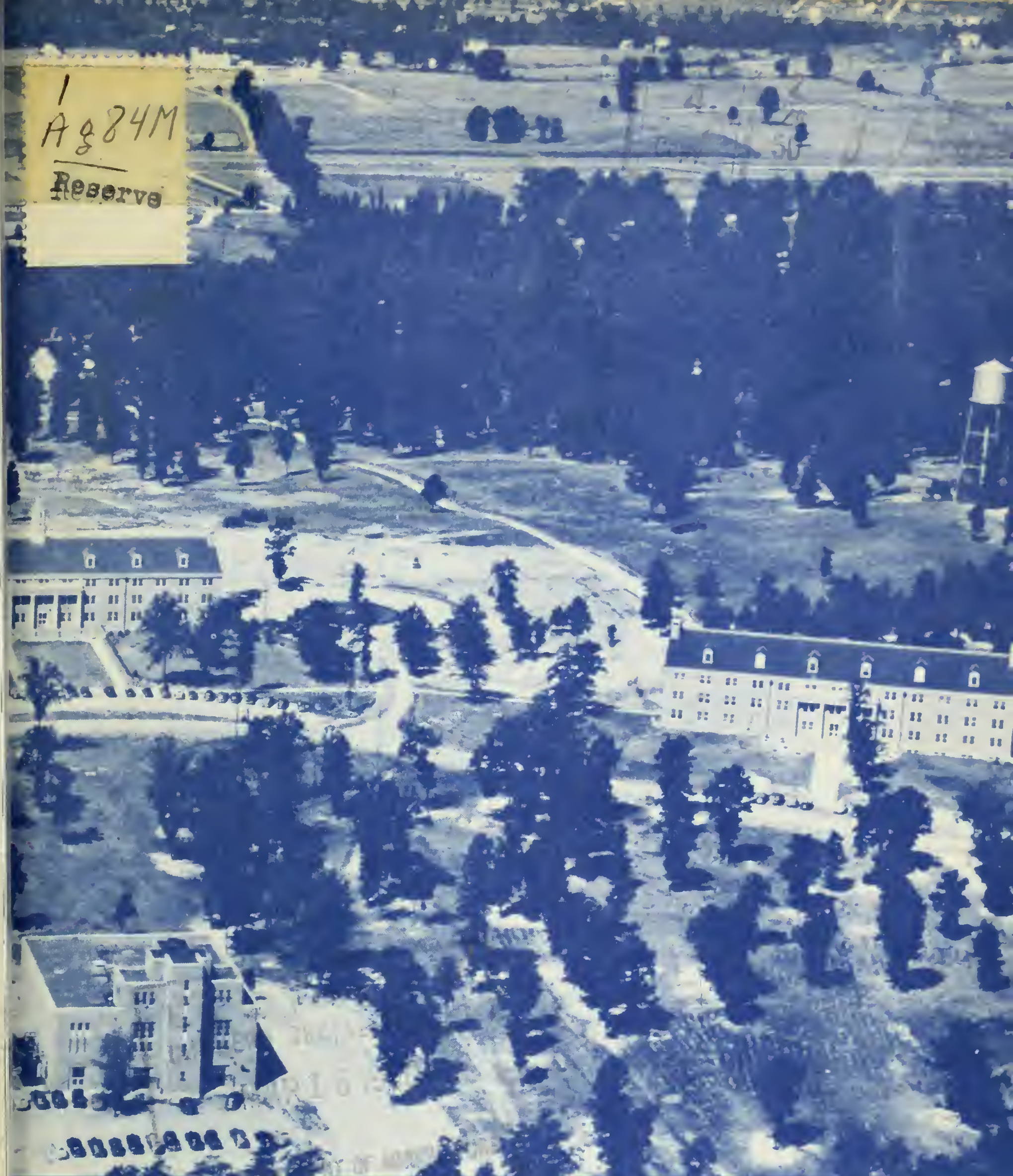


THE AGRICULTURAL RESEARCH CENTER

OF THE UNITED STATES
DEPARTMENT OF AGRICULTURE

MISCELLANEOUS PUBLICATION No. 697

DIRECTORY FOR VISITORS

	Person to See	*Room*	*Building*
Plant Industry Station, Bureau of Plant Industry, Soils, and Agricultural Engineering (BPISAE).	L. E. Childers	104	0.1
Dairy Industry	T. W. Moseley	102	1.1
Animal Disease Station, Bureau of Animal Industry (BAI).	A. B. Crawford	......	1.2
Animal Husbandry, BAI	Thomas H. Bartilson	6	2.1
Poultry Section, BAI	H. R. Bird	22–A	2.6
General Superintendent	C. A. Logan	121	3.1
Human Nutrition and Home Economics	Mrs. Zelta F. Rodenwold	119	3.1
Production and Marketing Admin.:			
Federal Seed Act	W. A. Davidson	209	3.2
Grain Standardization Research and Testing.	Lawrence Zeleny	220	3.2
Livestock Branch, Insecticide Division	C. G. Donovan	101	3.2
	Richard O. White	......	4.4
Insecticide Investigations, Bureau of Entomology and Plant Quarantine (E & PQ).	R. C. Roark	104	3.2
Cartographic Division, Soil Conservation Service (SCS).	J. M. Snyder	300	3.2
Agricultural Engineering, BPISAE	A. W. Turner	226	3.3
Biologically Active Chemical Compounds, Bureau of Agricultural and Industrial Chemistry.	T. D. Fontaine	114	3.3
Cafeteria	M. Daly	......	3.7
Zoology, BAI	E. W. Price	......	3.8
Bee Culture, E&PQ	J. I. Hambleton	110	4.6
Hillculture, SCS	C. S. Britt	......	5.3
Nursery, SCS	W. W. Steiner	......	5.4
Forest Service	E. J. Schreiner	......	6.1

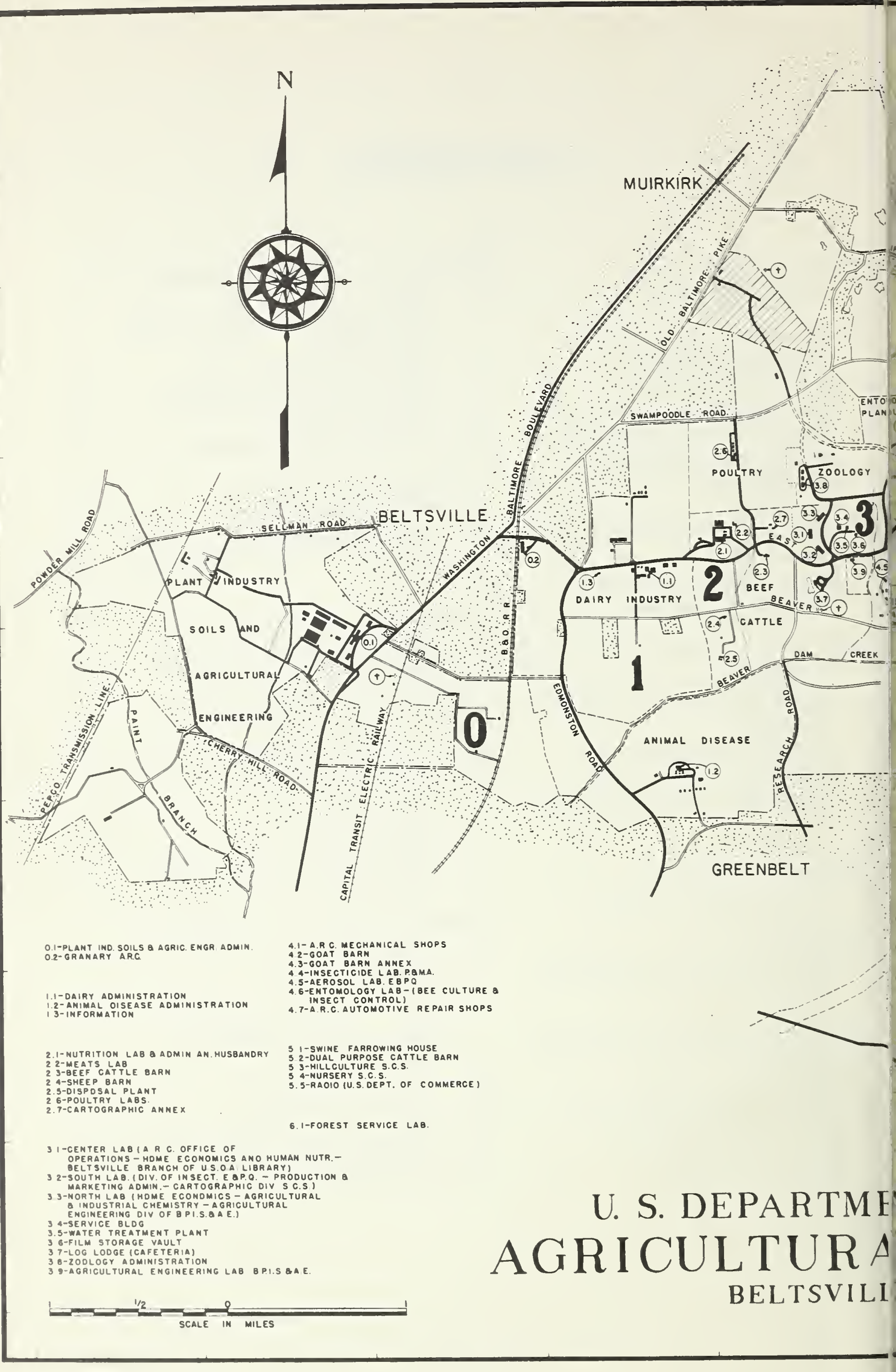
The Agricultural Research Center—*Where It Is and How To Get There*

The Agricultural Research Center extends over several square miles in Maryland near the town of Beltsville, about 13 miles from Washington, D. C. The map in this pamphlet shows the layout of the Center, which is in two separate tracts. On the northwest side of the Washington-Baltimore Boulevard, U. S. Route No. 1, is the Plant Industry Station. The entrance is about 2½ miles farther from Washington than the University of Maryland. About a mile nearer Baltimore, across a bridge over the B. & O. Railroad tracks, the road to the other part of the Center branches off to the right.

The best way to see the Agricultural Research Center is by private automobile, since many of the buildings are some distance from the road. The Washington-Baltimore busses of both the Greyhound and National Trailways lines stop in front of the Plant Industry Station. Certain Greyhound busses enter the grounds of the Center. Two special Greyhound busses leave the terminal at Twelfth Street and New York Avenue NW., at 7:10 a. m., Monday through Friday, arriving in front of the Center Laboratory (building 3.1 on the map) at about 7:55. This building is 2 miles from the regular bus stop at Beltsville. Most of the grounds and buildings are open during the usual weekday working hours, 8 a. m. to 4:30 p. m., but the buildings are closed Saturdays and Sundays.

It is best to make appointments for consultations with research specialists by telephone or by mail, either with the specialist or through Washington officials of the bureau concerned. The Animal Disease Station (1.2) can be visited only by appointment, since infectious diseases are studied there. Telephone numbers are: Department of Agriculture, Washington—REpublic 4142; Plant Industry Station—TOwer 6400; Research Center—TOwer 6430.

CONTENTS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2.7
3.1
3.2
3.3
3.4
3.5
3.6
3.7
3.8
3.9
4.5
0.1-PLANT IND. SOILS & AGRIC. ENGR. ADMIN.
0.2-GRANARY A.R.C.
1.1-DAIRY ADMINISTRATION
1.2-ANIMAL DISEASE ADMINISTRATION
1.3-INFORMATION
2.1-NUTRITION LAB & ADMIN. AN. HUSBANDRY
2.2-MEATS LAB
2.3-BEEF CATTLE BARN
2.4-SHEEP BARN
2.5-DISPOSAL PLANT
2.6-POULTRY LABS.
2.7-CARTOGRAPHIC ANNEX
3.1-CENTER LAB (A.R.C. OFFICE OF OPERATIONS-HOME ECONOMICS AND HUMAN NUTR.-BELTSVILLE BRANCH OF U.S.D.A. LIBRARY)
3.2-SOUTH LAB. (DIV. OF INSECT. E.&P.Q. - PRODUCTION & MARKETING ADMIN.- CARTOGRAPHIC DIV. S.C.S.)
3.3-NORTH LAB (HOME ECONOMICS - AGRICULTURAL & INDUSTRIAL CHEMISTRY - AGRICULTURAL ENGINEERING DIV. OF B.P.I.S.&A.E.)
3.4-SERVICE BLDG.
3.5-WATER TREATMENT PLANT
3.6-FILM STORAGE VAULT
3.7-LOG LODGE (CAFETERIA)
3.8-ZOOLOGY ADMINISTRATION
3.9-AGRICULTURAL ENGINEERING LAB. B.P.I.S.&A.E.
4.1-A.R.C. MECHANICAL SHOPS
4.2-GOAT BARN
4.3-GOAT BARN ANNEX
4.4-INSECTICIDE LAB. P&M.A.
4.5-AEROSOL LAB. E.&P.Q.
4.6-ENTOMOLOGY LAB-(BEE CULTURE & INSECT CONTROL)
4.7-A.R.C. AUTOMOTIVE REPAIR SHOPS
5.1-SWINE FARROWING HOUSE
5.2-DUAL PURPOSE CATTLE BARN
5.3-HILLCULTURE S.C.S.
5.4-NURSERY S.C.S.
5.5-RADIO (U.S. DEPT. OF COMMERCE)
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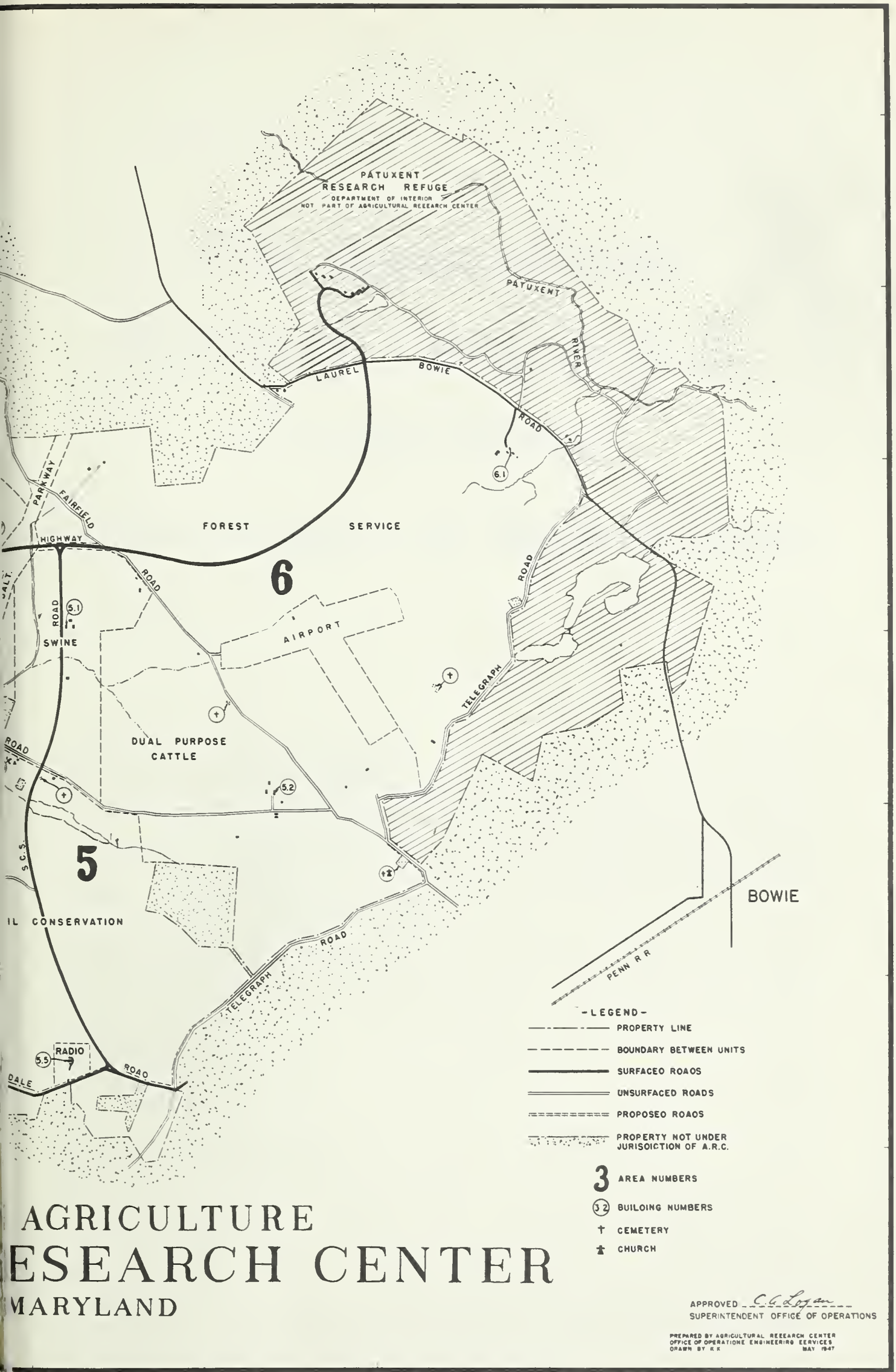
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LAUREL
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ROAD
FOREST
SERVICE
6
6.1
PARKWAY
FAIRFIELD
HIGHWAY
ROAD
5.1
ROAD
SWINE
AIRPORT
ROAD
TELEGRAPH
DUAL PURPOSE
CATTLE
5.2
ROAD
5
S.C.S.
IL CONSERVATION
ROAD
TELEGRAPH
BOWIE
PENN R R
RADIO
5.5
DALE
ROAD
-LEGEND-
PROPERTY LINE
BOUNDARY BETWEEN UNITS
SURFACED ROADS
UNSURFACED ROADS
PROPOSED ROADS
PROPERTY NOT UNDER JURISDICTION OF A.R.C.
3 AREA NUMBERS
3.2 BUILDING NUMBERS
CEMETERY
CHURCH
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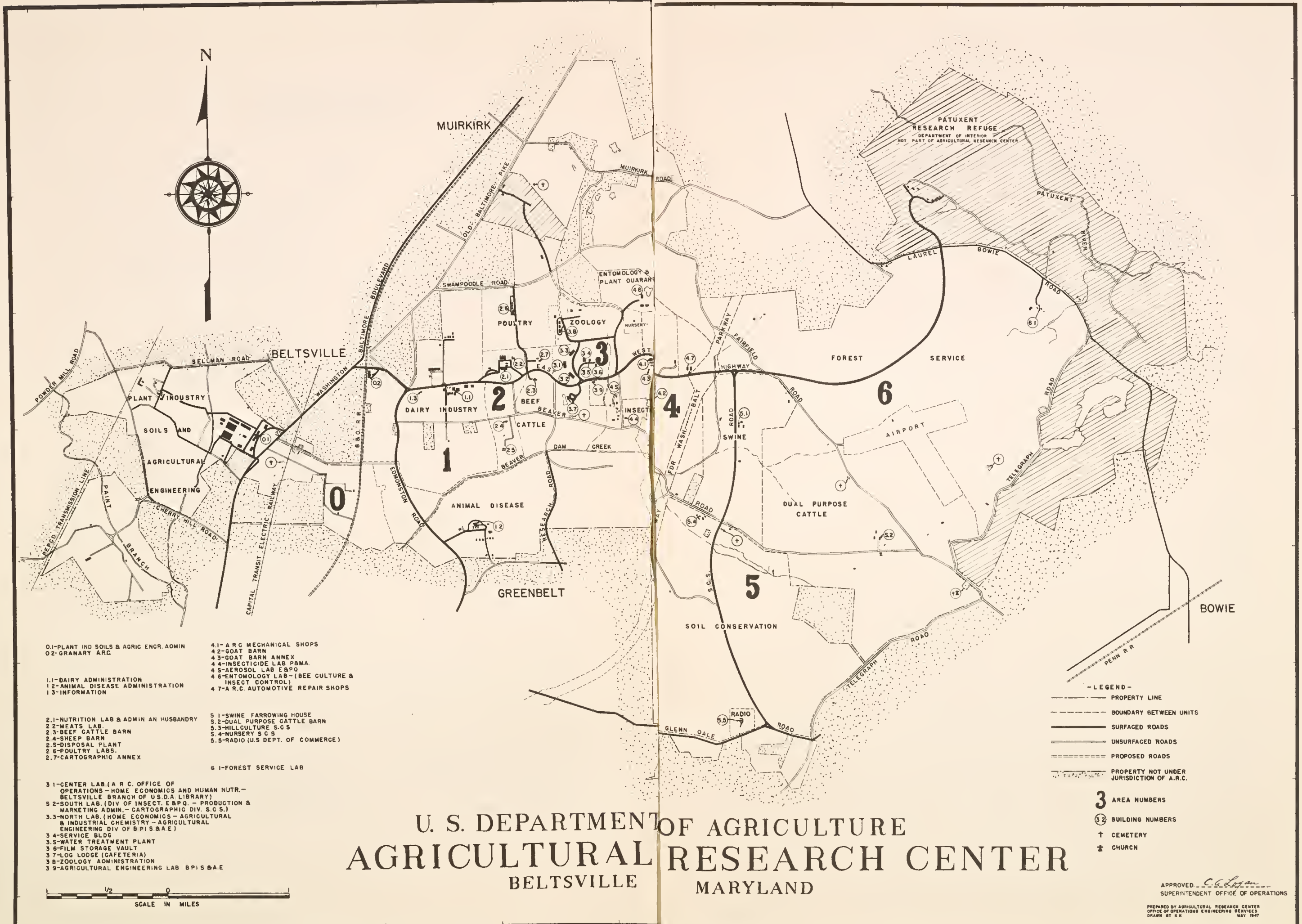


U. S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH CENTER
BELTSVILLE MARYLAND

The Agricultural Research Center of the United States Department of Agriculture

ONE of the largest areas in the world devoted to research on better farming and farm living, the Agricultural Research Center occupies approximately 12,000 acres near Beltsville, Md., several miles northeast of the Nation's Capital. It is a unit of the Agricultural Research Administration, which maintains it primarily for the benefit of its own research bureaus, though some other agencies of the Department and the Government also utilize its facilities.

Each of the States has an agricultural experiment station which deals chiefly with State or regional problems. The United States Department of Agriculture is primarily concerned with broad national problems. Nevertheless it frequently cooperates with a State in a regional investigation. Many of the research projects at the Research Center are carried on in cooperation with one or more of the State experiment stations. The results of all investigations are made available to the public through the Office of Information of the Department, at Washington, D. C., when they are considered by the scientists to be thoroughly proved.

This pamphlet is intended as a guide to visitors and an introduction to the work at the Research Center for interested persons unable to go there. Since the Center is so large and the research activities so varied, this description, incomplete as it is, will also serve to supplement and round out the somewhat sketchy impression of the work at Beltsville which is all that can be obtained in a short visit.

WORK COVERS A BROAD FIELD

In 1910 the Department of Agriculture acquired 475 acres of land in Prince Georges County, Md., to be used as an experimental farm by the Animal Husbandry and Dairy Divisions of the Bureau of Animal Industry. From that nucleus the Agricultural Research Center has expanded until it covers the present area of approximately 12,000 acres.

Besides the Bureau of Animal Industry and the Bureau of Dairy Industry (which grew out of the old Dairy Division), four other bureaus of the Agricultural Research Administration now have offices, laboratories, land, and other facilities at the Center. These are the Bureaus of Agricultural and Industrial Chemistry; Entomology and Plant Quarantine; Human Nutrition and Home Economics; and Plant Industry, Soils, and Agricultural Engineering, which has its headquarters at the Plant Industry Station. Other Department of Agriculture agencies that carry on research at the Center are the Forest Service, the Soil Conservation Service, and the Production and Marketing Administration.

The Bureau of Standards of the Department of Commerce maintains a radio station at the Center, mainly to transmit time signals. The Geochemical Prospecting Unit of the Geological Survey, Department of the Interior, is carrying on experimental work there, and the Patuxent Research Refuge of the Fish and Wildlife Service of the same Department occupies an area of 3,000 acres. The Veterinary Section of the Food and Drug Administration also carries on research at the Center.

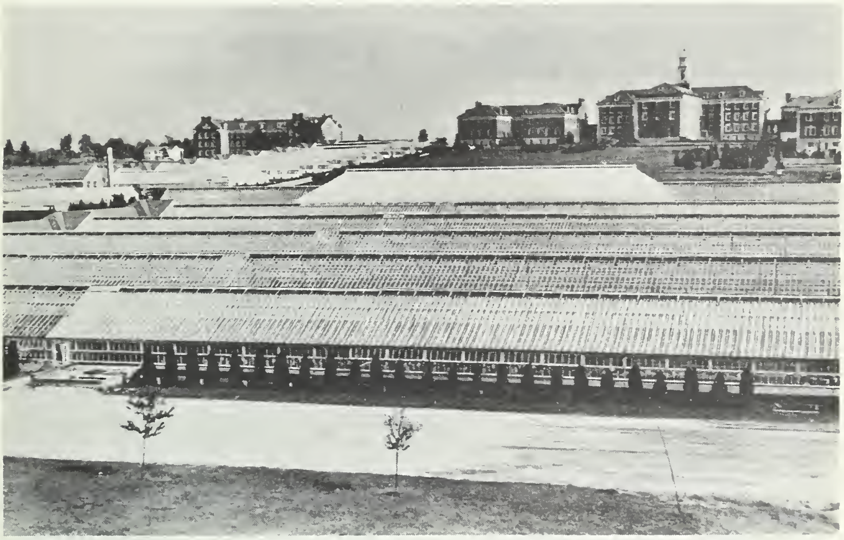
Workers and Their Tools

About 2,300 persons work for the Agricultural Research Administration at Beltsville. Scientific specialists include (to list them alphabetically) agronomists, animal husbandmen, apiculturists, architects, bacteriologists, biochemists, biologists, botanists, chemists, dairy technologists, engineers, entomologists, geneticists, grain technologists, helminthologists, home economists, horticulturists, mycologists, nematologists, olericulturists, nutritionists, parasitologists, pathologists, physicists, physiologists, statisticians, veterinarians, and zoologists. Often two or more bureaus cooperate in research, thereby bringing together the talents and experience of several groups of scientists. This strategy of combined attack on research problems from many angles has proved fruitful.

Nearly 3,000 experimental farm animals, more than 10,000 mature laying and breeding fowls, and about 5,500 small animals for use in laboratory tests, including guinea pigs, hamsters, rabbits, rats, and mice, are

kept at the Center. The dairy herd of 600 cattle consists mainly of Holstein-Friesians and Jerseys, with a small number of Red Danish. Other animals include dual-purpose cattle, horses, sheep (including some Karakul), hogs, and goats. The poultry flocks include chickens, turkeys, and pigeons.

Forty laboratory buildings, each constructed and equipped to meet the needs of a special kind of research, provide office and laboratory space for the Center's administrative officers, scientists, and other employees. In 31 greenhouses, 5 acres are under glass. There is an apiary for bees. Approximately 100 barns and storage buildings and 500 small-animal and poultry houses shelter the animals, fowls, and equipment. In addition the facilities include a granary, shops, warehouse, and heating, water-treatment, and sewage-disposal plants. These buildings, with roads, service facilities, equipment, and land, cost about $13,000,000. The land includes experimental pastures, ranges, orchards, gardens, fields for cultivated crops, timber stands, and soil-treatment plots.



Headquarters of the Bureau of Plant Industry, Soils, and Agricultural Engineering at the Plant Industry Station, showing some of the buildings and part of the greenhouse laboratories, where 5 acres are under glass.

BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING

New and Improved Plants

Plant breeders of the Bureau of Plant Industry, Soils, and Agricultural Engineering seek new varieties of fruits, vegetables, grains, grasses, fiber plants, oil plants, drug plants, and nuts that will meet the world's changing needs. One important requirement of a new variety is resistance to the diseases that from time to time threaten to destroy a whole industry. Other requirements are better eating quality, high yield, and good keeping and shipping qualities. Adaptation to some specific purpose, such as canning, preserving, or some other type of processing, is often desirable.

Modern plant breeders are not satisfied with selecting good types, getting them to breed true, and using them to replace the old ones. Rather, they formulate an ideal in their minds and proceed to create something that meets this ideal as nearly as possible by combining the genes—the units that transmit heritable characters from generation to generation—from two or more plants. Their ambition does not stop at getting a plant with a single desirable characteristic. They strive for many wanted characteristics in one plant—for example, high yield, high quality, and resistance to disease.

Better Vegetables, Fruits, and Flowers

Probably a third of the fruit and vegetable research at the Plant Industry Station has to do with breeding better varieties and strains. The other two-thirds is largely directed toward studies of soil management and crop nutrition, together with investigations of the causes and control of fungus, bacterial, and virus diseases of fruits and vegetables.

Ornamental plants also receive active attention by plant breeders here. Among other things, the breeders have provided new varieties and methods for the domestic bulb industry which have helped replace Japanese Easter lily bulbs with superior domestically grown lilies. Snapdragons, azaleas, carnations, and daffodils are also being improved through breeding research.

New lima bean varieties of good eating quality and dependable yields have been produced in several sizes adapted for different purposes and

for wide areas. One of these, Fordhook 242, introduced in 1943, has become the most important large-podded variety for shipping, for market gardeners, and for home gardens. Commercially acceptable types that are widely adapted and resistant to nematodes, insects, and diseases are objectives of the program, which has become country-wide in its scope through cooperation with State workers interested in lima beans.

A new heat-resistant, slow-bolting leaf lettuce, named "Slobolt," developed at Beltsville, has made lettuce growing for home use possible in areas where temperatures are too high for success with the old standard varieties. Slobolt has made it possible to have lettuce in the home garden throughout the summer in many parts of the country. A new early variety of head lettuce, called "Progress," was released by the U. S. Department of Agriculture and the New Jersey Agricultural Experiment Station in August 1948.

A potato-breeding project of wide scope centers in the laboratories and greenhouses at the Plant Industry Station and extends to various cooperating States. The cooperative National Potato Breeding Program of the Department and the States has brought out many new varieties that already stand high in the esteem of farmers and consumers. There is every indication that careful breeding work will create varieties of potatoes with resistance to the important diseases combined with other good qualities, such as right time of maturity, good shape, adaptation to a locality, shallow eyes, high yield, and good cooking characteristics.

To prevent the fruits from falling off potato plants painstakingly grown for breeding purposes, the potato specialist puts them into a bag.

Breeding work with onions has resulted in the development of sources of hybrid onion seed. The first hybrid onion, California Hybrid Red No. 1, has become established in early onion areas of the West and is being grown also in Australia, the home of one of its parents.

The fruit-breeding work of the Bureau of Plant Industry, Soils, and Agricultural Engineering and cooperating State stations is particularly important to growers of peaches, grapes, pears, strawberries, blueberries, and cranberries. The emphasis in the Plant Industry Station greenhouses is on crossing.

Strawberry breeders have grown more than 500,000 different varieties from which a few thousand seedlings were selected for further testing. Only 20 have been finally considered worth naming and introducing to the trade, though several others are still under test. Some are now widely grown commercially, to the great satisfaction of growers, shippers, freezers, and consumers. One, the Blakemore, is the most extensively grown variety in the United States today.

Tomato-breeding work in the Department of Agriculture began approximately 35 years ago. Even earlier than that there had been some work in leading tomato-growing States, directed especially to developing resistance to fusarium wilt. Since then, practically all of the old varieties have been replaced in commercial fields by new ones, and as a result the industry is on a sounder basis than formerly. Paralleling this improvement, there has been an enormous increase in tomato acreage. The concentration of the industry has made the disease problem greater and the need for new varieties more acute.

Great impetus was given to improvement in disease resistance in tomatoes through the introduction by the Department of the Peruvian wild currant tomato about 1930. This variety proved highly resistant to fusarium wilt and several other diseases of tomatoes. It has been used by many breeders in developing a number of new varieties, including some that are resistant to cladosporium leaf spot, a disease of much importance now in commercial greenhouses and in some fields where high humidity and cool temperatures are prevalent during the growing season.

Cereal and Forage-Crop Development

Cooperative work on cereal crops—hybrid corn (including waxy corn), waxy sorghum, wheat, oats, and other small grains—is centered at the Plant Industry Station. Hybrid corn has been pretty generally adopted by farmers in the United States. In 1948, 75 percent of the total corn acreage was planted to hybrids. In the Corn Belt States the percentage of hybrid corn was even higher. Iowa planted almost 100 percent, and Illinois, Indiana, Ohio, Minnesota, Wisconsin, Missouri, and Nebraska were not far behind.

Collections of varieties of small grains from all over the world are maintained at Beltsville. These include viable seed, renewed from time

to time, of wheat, oats, barley, rye, rice, and flax.

Cooperative forage-crop breeding work centers here in laboratories and greenhouses, and collections of seed of varieties of alfalfa, clovers, soybeans, and grasses from various parts of the world are maintained. Such collections provide a convenient supply for breeding work, and since the varieties and strains are kept pure they are an insurance against the loss of improvements built up at great cost.

Cold-Storage Experimentation

At the Plant Industry Station is a modern, fully equipped, experimental cold-storage plant, with 16 rooms in which temperature and humidity can be controlled. Here are studied the effects of growing practices and time of picking on storage quality of apples and other fruits; the influence of different methods of packaging and treatment on storage quality and loss from decay in fruits and vegetables; and the effects of carbon dioxide and of small quantities of ozone in the storage air on quality of fruits and vegetables and loss from spoilage.

Cold-storage investigations have brought many results of value. For example, it has been found that the eating and canning qualities of the Kiefer pear—grown largely in the Southeastern States—can be greatly improved by keeping the fruit at certain temperatures. Another example is the great saving in transportation costs—as much as $1,000,000 a year—that has been brought about through the adaptation of findings of research on the icing of vegetable and fruit refrigerator cars.

Drug Garden, Fungus Collections, and Soil Samples

More than 200 species and varieties of drug and savory herb plants are maintained in a cultivated garden at the Plant Industry Station. The plants are grown in 40-foot rows and labeled with their scientific and common names. A number of perennials are included. The garden is at its prime in summer and early fall.

Half a million specimens of fungi are kept in the herbarium of the Division of Mycology and Disease Survey in the North Building, Plant Industry Station, the second largest collection in the United States. One unit is kept at Beltsville under a cooperative agreement with the Smithsonian Institution, and others belong to the Divisions of Forest Pathology and of Sugar Plant Investigations. More than 25,000 species of fungi are included, with about 7,500 species represented by type material or the equivalent. Particular attention is given to fungi that cause plant diseases. Fungus determinations are made and mycological information is furnished.

In the same building is a collection of living cultures of fungi that cause extensive decay of living forest trees and structural timber. This collection, the largest of its kind in the world, serves as a basis for durability studies on woods essential to airplane, boat, and building construction as well as for diagnosis of tree diseases.

The Soil Survey Division has, in the North Building, a large and constantly increasing collection of samples of soils from all parts of the world. Although the collection is for correlation purposes, to insure uniformity of names and descriptions for soil types and series as they occur in different parts of the country, visitors to the Plant Industry Station may see it.

Research With Radioactive Chemicals

Preliminary work has been started, in cooperation with the Atomic Energy Commission, to provide special facilities at the Plant Industry Station for expanding plant and soil research using radioactive chemicals.

The $200,000 building program calls for a greenhouse and headhouse with full basement, containing constant-environment growth rooms;

A soil scientist weighs radioactive phosphate, which will be compounded into a fertilizer for tracer tests. He works in a special laboratory equipped with lead shields, long-handled tools, and other safety devices. The material, which comes from the atomic pile at Oak Ridge, Tenn., is extremely dangerous to handle unless correct precautions are taken.

so-called "hot" laboratories designed for handling radioactive isotopes; improved facilities for the manufacture of radioactive materials and of soil amendments such as lime and related materials; and an area for small-scale field experiments. The new structures will occupy an area of about 2½ acres.

Extensive new research is planned on the safe disposal of liquid radioactive wastes at installations of the atomic energy program by ascertaining exactly how radioactive elements behave when introduced into the soils; the movement, fixation, and release of different plant nutrients in various soil types by use of radioactive techniques, investigations which will provide new and more precise knowledge on how and when to plow and fertilize different crops on different soils; and development of procedures for safe and effective use of radioactive isotopes in soil and crop research. The facilities will also make possible the manufacture of fertilizers incorporating radioactive trace elements for use by other agricultural research agencies and a training program for scientists in the use of isotopes in soil and crop research.

Investigations using radioactive phosphorus to trace fertilizer uptake in 13 different crops show a wide variation in the utilization of phosphorus by crops. The research has shown that the actual amount of phosphorus used by plants is relatively low. Cotton, corn, tobacco, or soybeans use less than 10 percent of an application of 100 pounds of phosphoric acid. Potatoes use a somewhat higher percentage.

Placement studies are showing methods of increasing the efficiency of applied phosphorus. Sugar beets fertilized with a band 4 inches to the side and 4 inches below seed level did not use the phosphorus until the plants were 5 inches high, but those treated with fertilizer mixed in the seed row 4 inches wide and 4 inches deep used the fertilizer from the beginning of growth.

Higher Than Sound

Practical agricultural applications of ultrasonics and some of the problems of using high-frequency sound radiations produced electrically are under study by agricultural engineers at the Center.

In limited cooperative tests with the Bureau of Entomology and Plant Quarantine ultrasonic waves killed mosquito larvae in 5 seconds. Results show the percentage of mortality of the larvae to be correlated directly with the amplitude of the waves. Exposures of up to a full minute were required for killing larvae of the codling moth, and those embedded in fruit were apparently undisturbed.

In another study to find whether ultrasonic sterilization offers a feasible means of controlling fruit fly in citrus fruits, the researchers found that exposure to the rays decreased the vitamin C content of the orange juice. The longer the exposure, the less vitamin C remained.

Other tests indicate that treatment with ultrasonics will reduce the germination period of certain seeds and tubers. The vibrations will also reduce particles of DDT to smaller size than has been possible heretofore by the usual processes.

Agricultural uses which appear to warrant immediate investigation include the biological effects on plant and animal materials, bacterial control, sterilization or pasteurization of milk and other food products, homogenization of milk, emulsification and near dispersion in liquids, coagulation of particles suspended in fluids, and control of insects and diseases.

Forage-Curing Methods Under Study

Agricultural engineers and forage, dairy, and marketing specialists are cooperating to study the relative efficiency of various methods of harvesting and preserving forage. Each method is evaluated in terms of losses in dry matter, protein, and carotene and effect on milk yields per acre.

In trials with alfalfa, dehydration gave the highest return in milk yields. Barn drying with supplemental heat rated second. Then, in turn, came wilted silage, barn curing without heat, and field curing, which, even when the weather is favorable, is the least efficient of the five methods.

Leaves and other fine stuff left after haying are important in determining the efficiency of various methods of harvesting and curing forage for winter feed. Engineers at the Agricultural Research Center use this experimental vacuum-type gleaner to pick up these materials from the field.

Designing Farm Machinery

The fertilizer distribution machinery laboratory at the Research Center is one of six projects in the United States where agricultural engineers of the Bureau of Plant Industry, Soils, and Agricultural Engineering are doing developmental work on farm machinery. The other five projects are located in major producing areas. All research in the actual use of the machines is done at the field stations and in cooperation with State experiment stations.

The engineers have studies in progress on preparation of seedbeds, placement of fertilizers, application of insecticides and fungicides, and planting, cultivating, harvesting, and handling crops. The object is to enable farmers to get maximum yields of high-quality products at minimum cost. Industry makes use of the results obtained and of new principles discovered to design machines that help farmers gain these objectives.

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BUREAU OF AGRICULTURAL AND INDUSTRIAL CHEMISTRY

Cooperative Work on Plant-Growth Regulators

Application of organic chemicals to plants to produce modifications in the rate and type of growth is now widely practiced. Examples are the use of the compound 2,4-D to kill broad-leaved weeds without injuring desirable grasses, and of naphthaleneacetic acid to prevent premature drop of apples. It is known, however, that in some cases these chemical plant-growth regulators produce undesirable as well as desirable effects on plants. Investigations of the way these compounds act on plants and studies of the mechanism of their action are being conducted by the Division of Biologically Active Chemical Compounds in building 3.3, in close cooperation with the Bureau of Plant Industry, Soils, and Agricultural Engineering.

In these studies organic plant-growth regulators are synthesized and applied to growing plants. Their entry, passage through the plant, and final location in the plant have been accurately determined by using radioactive tracer techniques. Through this work it has been demonstrated for the first time that growth regulators of the 2,4-D type are actually absorbed by the plant and are transferred to the part that is developing most rapidly at the time of application. These substances at certain concentrations inhibit the growth of broad-leaved plants (dicotyledons) but do not affect the growth of grasses (monocotyledons). This difference is due to differences in the manner in which the plant constituents react to the compound.

Study of Plant-Disease Resistance

Nearly all plants are prey to certain bacterial, fungal, or virus diseases. Such diseases are often responsible for major crop failures, which result in economic losses to the farmer and, ultimately, in increased costs to the consumer. For this reason, plant-disease control has long been a problem of paramount importance to the agricultural scientist. Intensive plant-breeding experiments have developed varieties of crop plants that are highly resistant to specific disease-causing organisms. As a result of this research, plant geneticists can produce two tomato plants, for ex-

ample, which look alike and grow and develop alike when grown in clean soil, but one of which will wilt and die when both are grown in soil infected with the Fusarium wilt fungus.

What is it in the chemical make-up of a plant that enables it to resist infection? The Division of Biologically Active Chemical Compounds is trying to find an answer to this question through its cooperative research at the Center. Because some varieties of tomato were known to have resistance to the wilt caused by the Fusarium fungus, this plant has been the principal subject of research. It is believed that an understanding of the chemical factors involved in conferring resistance on certain varieties of tomato may provide clues to a general understanding of disease-resistance mechanisms.

A substance has been isolated from tomato plants that prevents the growth of the Fusarium fungus and is believed to play a part in protecting the resistant varieties against wilt disease. This substance has been appropriately named "tomatine." Experiments are now under way to devise means for the practical application of these findings in the control of tomato wilt. The investigations will include other important plants and the diseases to which they are susceptible.

Another important phase of plant-growth-regulator investigations is the isolation, identification, production, and evaluation of hormones from agricultural sources. The isolation of the naturally occurring chemical substances in plants which regulate their growth may shed light on the mode of action of synthetic plant-growth regulators.

Antibiotics From Higher Plants

Although the term "antibiotic" is of recent origin, chemical substances from plants, in one form or another, have been used for the treatment and cure of diseases for centuries. An antibiotic may be defined as an organic chemical substance, produced by a plant, an animal, or a micro-organism, which selectively inhibits the growth of or completely destroys bacteria, viruses, fungi, or other disease-producing organisms.

Plants are a potentially rich source of antibiotics. In a survey conducted by the Division of Biologically Active Chemical Compounds approximately 40 percent of the extracts from higher plants tested exhibited either antibacterial or antifungal activity or both. Representative micro-organisms of several types have been used to test the potency of various plant extracts. Among the plants or plant parts whose extracts show promise of being good sources of antibiotics are the sweetpotato plant and tubers, cabbage, bananas, cacti, lettuce, celery, cucumber, broccoli, and muskmelon. A great need exists for additional antibiotics with wider ranges of activity and of low toxicity to man. Perhaps chemical substances isolated from agricultural sources will supply part of the need.

Microbiology of Agricultural Products

Bacteria, yeasts, and molds are more or less closely associated with agricultural products and present peculiar and often difficult problems. Success in the preservation of agricultural products depends largely on the control of spoilage micro-organisms. The numbers of these micro-organisms present, how they are affected by processing, under what conditions they develop, and their influence on the nature of the product, palatability, and wholesomeness are problems inherent in most agricultural food products.

At present, the Microbiology Research Division of the Bureau of Agricultural and Industrial Chemistry (in building 3.3) is conducting research on the microbiology of eggs and egg products. Special attention is being given to determining the presence in these materials of spoilage micro-organisms and bacteria of public-health significance such as may cause food poisoning. Studies are also being conducted on the development and improvement of methods for the microbiological examination of foods and on the application of this information to the commercial preservation of eggs and egg products. Similar studies are also being conducted on precooked frozen foods of a wide variety of types.

A biochemist in a Beltsville laboratory examines two batches of pure crystalline tomatine.

SOIL CONSERVATION SERVICE

Soil and Water Conservation

Conservation farming means treating every acre according to its individual needs and using every acre according to its individual capabilities. On a 1,700-acre tract on the south side of the Research Center, the Soil Conservation Service is applying this principle to the land—developing new conservation farming methods, working out improvements of methods now in use, and studying erosion-resistant plants.

On various fields, curving rows that follow the contours of the natural landscape mark experimental plantings to test variations and potential improvements of such conservation practices as contour cultivation, ridge rows, rotations, mulching, and cover crops. Particular attention is devoted to methods of safeguarding the productiveness of the hilly tobacco land of southern Maryland.

Studies in soil physics are carried on at a laboratory on the tract to determine the effects of different experimental treatments on the soil. The studies are made to determine the causes of the success or failure of different conservation management practices when applied to different kinds and conditions of soil. These studies are of the type often called fundamental research; they deal chiefly with soil-water relationships and the development and maintenance of soil structure.

Part of the tract is used as a national center for the assembly and testing of erosion-resisting plants of economic value. Here, new and improved grasses, herbaceous legumes, and woody plants collected from the wild, introduced from abroad, or developed by cooperating research agencies are studied and compared. The plants, carefully recorded and labeled, first are grown in small plots. As individual species and strains show superior conservation values they are sent to regional testing centers for final evaluation and distribution to farmers.

The Service's Cartographic Division maintains (in buildings 3.2 and 3.4) facilities for constructing and reproducing maps, charts, mosaics, aerial and still photographs, and technical drawings. This service unit supplies aerial photographs, mosaics, maps, drawings, and charts used by technicians and farmers in making over-all and detailed plans for applying conservation practices to farm land.

FOREST SERVICE

Forest Research and the Experimental Forest

Research in forest management, forest-tree breeding, and reforestation is carried on by the Forest Service's Northeastern Forest Experiment Station on a 3,000-acre experimental forest located on the east side of the Research Center. This experimental forest provides opportunity for research under conditions typical of much of the Coastal Plain oak-pine forests of Maryland and adjacent States.

The experimental forest is being used to develop improved cutting methods for the much-abused second-growth oak and pine forests that cover several million acres of poor and worn-out land in this region. How to make forestry profitable is a particularly urgent problem in this timber type, which currently has a relatively low commercial value. Here foresters are studying the possibilities of converting the present inferior oak-pine stands into good forests of more valuable trees. The problems peculiar to owners of woodlots and small forests are being given special attention.

The forest-management studies are aimed primarily at developing financially feasible ways of bringing the forest to higher productivity. The effectiveness of cultural measures to improve immature stands and of harvest cuttings in promoting natural reseeding is being evaluated, along with the relative merits of different logging methods. Repeated inventories of the growing stock on experimental areas form the basis for rating the silvicultural benefits of the several measures.

Some of the Northeastern Forest Experiment Station's forest-tree-breeding research is being conducted on the experimental forest. Major emphasis here is on hybrid poplars, more than 200 of which are being tested for disease resistance. The less susceptible clones are propagated for extensive regional tests. Field plantings of poplar, soft maple, and pine hybrids also have been made.

Several tree-planting studies are under way in two difficult situations: one, an area very severely burned in an accidental fire, and the other an area of sterile subsoil exposed in constructing the airport. Heavy sprout and shrub competition must be overcome on the burned area. On the subsoil area methods of soil stabilization with herbaceous vegetation were devised as preparation for tree planting. Results of these studies have application on the very considerable areas in the region still subject to severe fires, and on areas being severely disturbed, as by strip mining for coal.

BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

Insecticides, New and Old

Some of the most common of our insect pests, including flies and mosquitoes, need no longer be accepted as necessary evils. Modern insecticides, combined with new methods of spraying, dusting, and fumigating, will go far toward wiping out these menaces to human health and happiness. Chemists and entomologists of the Bureau of Entomology and Plant Quarantine, however, continue to search for better methods and materials for controlling the insect enemies of man, his animals, and his crops.

The advent of DDT a few years ago put renewed life and interest into the search for newer and better chemicals for combating injurious insects. A number of other new and, in some cases, highly effective insecticidal materials have since been discovered. Scientists of the Bureau who played a great part in the development of DDT have also done much to develop the use of such materials as tetraethyl pyrophosphate, parathion, benzene hexachloride, chlordane, and toxaphene. Tests may at any time disclose others with good possibilities. The Bureau's chemists have synthesized many entirely new organic compounds, some of which have proved to have high insecticidal value.

There is still much to be learned concerning the advantages and disadvantages of these newer materials over those that have long been in use in insect control. The pyrethrins are an example of an effective old insecticide. These insect-killing principles of pyrethrum, a species of chrysanthemum that is grown commercially mainly in the Kenya Colony, Africa, have been widely used for many years. They have the advantage of being comparatively harmless to man and animals. A recent achievement of Bureau chemists is the synthesis, in the Beltsville laboratory, of compounds almost identical with the active insecticidal esters in pyrethrum. Some of these compounds are superior to the natural material in insect-killing power. Rotenone, also long and widely used in insect control, is the chief insecticidal constituent of derris, the roots of which Chinese market gardeners in the Malay Peninsula have used for centuries to kill insects attacking their crops, and of cube (pronounced coo-bay), which grows in South America. Beltsville chemists were the first to determine the correct chemical structure of rotenone.

In testing new materials each one is carefully evaluated with regard to many factors. These include: The effectiveness of the material against a wide variety of insects in their various stages; determination of the most suitable formulations to be used under specific conditions; the effect of various supplemental materials, such as emulsifiers and synergists, on toxicity; injurious effects of the material on animals, plants, and beneficial insects; and the possible harmful effects of residues that may accumulate in soils or on crops. Carefully planned experiments, first in the laboratory and then in the field, must be carried on. Many replications over long periods are often necessary to obtain satisfactory and dependable answers to these questions. Years of research and testing are back of every new commercial insecticide that appears on the market.

The headquarters and largest laboratory for chemical investigations of insecticides at Beltsville are in building 3.2.

For Better Control of Insect Pests

About a mile northeast of the building in which the chemical work on insecticides is done are other units devoted to entomological research. Here are located laboratory buildings A, B, C (group 4.6 on map), greenhouses, orchards, and a mushroom house.

A portion of the space on the second floor of laboratory building 4.6 A is devoted to work on fruit insects. A testing orchard of 700 trees is available near this laboratory for preliminary field studies.

Directly south of laboratory A is laboratory C, the headquarters for certain research work on insects affecting forests. Laboratories dealing with insect pests of cereal and forage crops are also in operation here. The forest-insect office gives general supervision to a research program conducted at 10 regional field laboratories on a wide variety of problems, including the control of pine bark beetles in western forests and the development of practical methods for controlling such important forest defoliators as the spruce budworm and the Douglas-fir tussock moth.

The research work conducted by this unit at Beltsville has to do primarily with the development of measures for controlling insect pests of forest and shade trees and forest products. DDT and benzene hexachloride have proved effective in the forest for the prevention and control of many bark-infesting and leaf-eating insects, and several large-scale projects have been undertaken with various States and governmental agencies to apply these materials over large areas to control injurious forest insects. Observations are made to determine whether such applications adversely affect beneficial forms of life such as birds, fish, and bees and other useful insects. In connection with this work, airplanes and equipment for developing improvements in aerial applications of insecticides to forest areas are maintained at the airport at the Research Center.

Work with soil poisons to protect the foundations of buildings from termite attack is also carried on from laboratory C. Chemicals for use in protecting insulating and foundation materials, plywood, and military supplies are also being tested in cooperation with the Department of National Defense.

Investigations are in progress on the control of the potato leafhopper as it affects alfalfa and peanuts and on the control of the tobacco thrips and corn rootworm as pests of peanuts. DDT and some other new insecticides are showing much promise for use against these insects.

Extensive series of new wheats and barleys are being developed here for resistance to hessian fly and sawflies, in cooperation with Department and State agronomists. High resistance to hessian fly has been bred into several very promising new varieties of wheat which may eventually be released for commercial use.

Due east of laboratory C is laboratory B with an attached range of greenhouses. This unit was designed and is used primarily for a study of greenhouse-plant pests. DDT, parathion, and tetraethyl pyrophosphate aerosols have proved effective in controlling thrips, aphids, mealybugs, and other insect pests on roses and other greenhouse plants. Outstanding results have been obtained in control of the two-spotted spider mite in commercial tests on roses through the use of a tetraethyl pyrophosphate aerosol.

East of laboratory B is the mushroom house, where experimental work is carried on to develop methods for control of insects and mites attacking mushrooms.

At building 4.5 investigations are being conducted on methods of ridding airplanes of insects by means of aerosols and residual spray treatments. These studies also determine the effect of the different treatments on the interior surfaces of planes to avoid injury to paints, plastics,

The Bureau of Entomology and Plant Quarantine maintains four airplanes at the Research Center airport for use in research in aerial spraying methods and equipment.

Wearing a gas mask, a research worker sprays greenhouse plants with an aerosol that has proved effective in controlling pests in greenhouses.

upholstery, etc. Tests are conducted here on the efficiency of new equipment for applying insecticides, such as high-speed blowers, and mechanical and heat generators for aerosols. Investigations on methods of disinsectizing plants and plant products, mainly by fumigation, in order that they may move in commerce in conformity with foreign and domestic plant quarantine regulations, are also carried on here.

Entomologists' Guinea Pigs

Codling moths, Mexican bean beetles, mosquitoes, houseflies, and spider mites are to the entomologist what guinea pigs, rabbits, and white rats are to the biologist. Great numbers of these insects and mites are reared in cages and greenhouses at Beltsville and used by entomologists for testing materials under controlled laboratory conditions in the hunt for new insecticides. Only about a dozen out of every thousand of the substances tested pass the preliminary entomological trials. Those are sent to field stations of the Bureau for larger scale tests under actual conditions in fields and orchards.

In one test of stomach insecticides—those that kill insects that eat them—newly hatched apple worms are turned loose in a test-tube "orchard" which has been sprayed with the material under test. The orchard consists of glass vials with an apple plug in the top of each one, arranged in rows in a wooden rack. The number of worms killed by eat-

ing the sprayed apple is an index of the value of the insecticide.

A different technique is required for testing contact insecticides, which kill on contact with insects' bodies. One apparatus for such tests consists of large aluminum cylinders mounted on a turntable. Several cylinders can be treated at approximately the same time by rotating them into position in front of a fixed applicator. A hundred or more healthy houseflies in a shallow glass cage topped with wire screen are placed in the bottom of each cylinder and the test material in measured quantities is sprayed into the top. The count of flies that survive or succumb after a treatment in the cylinder tells how effective the material is as a contact insecticide. A more practical test on flies and mosquitoes is made by spraying the insecticide into a specially constructed six-foot-square room.

An Insect "Clinic"

Studies in insect physiology are necessary for a better understanding of the toxic action of insecticides. Just as improved methods of medical practice have been developed to a great extent on the basis of fundamental studies in the field of vertebrate physiology, so basic studies in insect physiology are needed as a background to the practical methods of insect control. An insect possesses stomach, kidneys, heart, blood, muscles, nerves, and other cells, tissues, and organs, just as does a verte-

Counting the flies killed by an insecticide under test. The apparatus—aluminum drums on a turntable—was especially designed for these tests.

brate. Information is needed on how these tissues and organs function normally and how their functioning is affected by different insecticides. The Bureau of Entomology and Plant Quarantine is carrying on clinical investigations along these lines in building 4.6 A, where not the life and health but the death and destruction of the insect patients are the ultimate objective.

Whether an insect eats an insecticide or the insecticide penetrates its skin or is breathed into its respiratory system, eventually the poison gets into its blood stream, attacks certain of the tissues, and causes death. In studying the effects of insecticides on the blood, cells, heart, and stomach, injections are made directly into the blood stream of an insect by means of a small hypodermic syringe or a specially devised injection pipette. In quantitative experiments, each individual insect is weighed, and the dosage given it is adjusted to its body weight. Fundamental information on insecticidal action is thus obtained.

Helping Bees to Help Us

Although injurious insects hold the center of the entomological stage at Beltsville, the honeybee, a beneficial insect, has an important place there, too. Recent years have seen a growing realization of the importance of the beekeeping industry to agriculture in general. Bees are indispensable in the pollination of some 50 important crops. Headquarters for beekeeping problems are on the first floor of laboratory 4.6 A.

There are in the world today many varieties and strains of bees, each different from the others in usefulness and in ability to resist disease. Apiculturists are trying to breed strains that will excel as honeymakers, will display increased efficiency as pollinators, and will have an inborn resistance to American foulbrood, a fatal bee infection that annually destroys thousands of colonies. Since bees refuse to breed in captivity, the controlled breeding necessary to produce the new strains sought must be done artificially by means of instruments.

In research on bees as pollinators, studies are being made to determine how to use honeybees and other bees most efficiently in the pollination of legume seed crops, particularly alfalfa and the various clovers. These studies cover the pollinating behavior of bees, the effect of the field use of insecticides on the pollinating insect population, the management of the honeybee colony for pollinating purposes, the number of colonies needed per acre, the proper place to set the hives in relation to the field, methods for directing the bees to the crop, and the effect of competitor plants.

PRODUCTION AND MARKETING ADMINISTRATION

Testing Commercial Insecticides and Other Killers

At the laboratories maintained in buildings 3.2 and 4.4 and in the greenhouses, gardens, and orchards adjacent to the latter building, the Insecticide Division, Livestock Branch, Production and Marketing Administration, tests samples from interstate shipments of commercial insecticides, fungicides, disinfectants, rodenticides, and weed killers. This Division administers the Federal Insecticide, Fungicide, and Rodenticide Act of June 25, 1947, which is intended to protect farmers, livestock raisers, orchardists, and householders from losses and possible personal injury through faulty, misbranded, or adulterated products. Under the law all such products must be registered with the Department of Agriculture.

Grain Standardization Research

Offices and laboratories of the Production and Marketing Administration for conducting grain standardization research are maintained in building 3.2 at the Research Center. Standards have been established for most farm products. Before the formulation of Federal standards for grain about 30 years ago, grain marketing was in a chaotic condition, with a great variety of local standards and no uniformity in their application. Federal grain standards now provide the medium of a common understandable language between buyers and sellers. Official inspection gives an unbiased appraisal of the quality and condition of grain, independent of buyer or seller.

To supply background information for the inspection of grain, the Standardization Research and Testing Division of the Grain Branch performs mechanical, chemical, milling, and baking tests on samples of grain found in commerce. The purpose is both to improve the structure of the standards to meet changing conditions and to work out new and improved methods of evaluation that can be translated into terms of practical inspection service. Similar standardization studies are being made on rice and other farm products, including hops, peas, beans, hay, and straw.

Of major importance have been the development and standardization of mechanical equipment for use in grain-inspection work to eliminate

the personal element. This equipment includes a divider that cuts down large samples into aliquot portions for analysis, an improved test-weight-per-bushel apparatus, standard dockage machines for cleaning grain, sieving apparatus for kernel-sizing tests, and rice-shelling devices for determining the milling quality of rough rice.

Testing Miscellaneous Commodities

The Grain Branch of the Production and Marketing Administration is responsible for inspecting and testing a wide variety of commodities, including flour, cereals, and other grain products, vegetable oils, vitamin products, soaps, and many other commodities purchased by the Commodity Credit Corporation, and for testing certain of these products purchased by the Department of National Defense. During the fiscal year ended June 30, 1948, approximately 18,000 lots of these various commodities were tested at Beltsville. This work included approximately 80,000 precise chemical or physical tests. The Beltsville laboratories also supervised the testing of an estimated 36,000 lots of miscellaneous commodities by commercial and other laboratories under the direction of field offices of the Grain Branch. The total value of the various com-

Preparing a sample of field pea seeds for a germination test. The tray in the seed technologist's left hand is a vacuum counter which automatically counts out the number of seeds desired.

modities inspected under this program during the fiscal year is estimated to be in excess of $200,000,000.

Insuring Seed Quality

Because seeds look more or less alike to laymen, farmers need some assurance that seed they buy will produce the kinds of plants they have a right to expect from reading the label or advertising statements, and that the seed will germinate. To provide this assurance, Congress passed the Federal Seed Act in 1939. This act, enforced by the Production and Marketing Administration, requires complete and truthful labeling of seed shipped in interstate commerce for seeding purposes and prohibits false advertising. It prohibits also the importation of seed that fails to meet certain standards of quality.

To make sure that seedsmen are complying with the law, the Production and Marketing Administration each year examines hundreds of samples of seeds taken from interstate channels of trade by State inspectors under State seed laws. These seeds are tested at the Federal seed testing laboratory at Beltsville and, under the supervision of this laboratory, at field laboratories in California, Missouri, Minnesota, and Alabama.

Germination tests on these samples reveal the viability of seeds in each shipment. The tests are made by placing a counted number of seeds on moist blotting paper or towels or in sand or soil and letting them remain for a number of days in a cabinet kept at the temperature best suited for the germination of that particular kind of seed.

Aerial Photographic Negatives

The Production and Marketing Administration uses space at the Research Center for storage of aerial photographic negatives, used in making the aerial pictures that play an important role in administering the farm program. These photographs and the facilities of the PMA aerial photographic laboratories were utilized by the War and Navy Departments during the war. Photomaps of over 160,000 square miles were compiled from aerial photographs at the laboratories for the use of the War Department.

More than 16,000 rolls of aerial photographic negatives, each longer than 100 feet and representing altogether pictures of more than 2½ million square miles of land area, are stored in fireproof, air-conditioned vaults. These negatives are taken to Department laboratories in Washington for use as needed, then returned to the vaults at the Center for filing and safekeeping.

BUREAU OF DAIRY INDUSTRY

Building Better Dairy Herds

Dairy research at Beltsville is concerned with numerous problems that affect the efficiency and profitableness of dairy farming. The work includes studies in breeding, feeding, and management to improve the milk-producing ability of dairy animals; determination of their nutritional requirements for normal growth, lactation, and reproduction and the feeds or feeding regimes that will supply the needed nutrients most efficiently; and investigations of the physiological factors affecting the general usefulness of dairy cattle.

The experimental herds now consist of 500 females and 100 bulls of all ages—representing Holsteins, Jerseys, and crossbreds of various breeds. Land used for pasture and hay crops in connection with dairy operations consists of about 500 acres. In addition, the facilities at Beltsville include a well-equipped laboratory building for dairy-products research.

A big problem in breeding dairy cows has been how to reduce the percentage of the low milk producers born in practically every herd each year. It has been estimated that only one-third of the country's dairy cows return a profit, one-third break even, and one-third fail to pay for their keep.

Records of the production of cows in the Beltsville dairy herd, kept for over 30 years, have proved the theory advanced by scientists of the Bureau of Dairy Industry that a bull whose daughters are consistently better milk producers than their dams is relatively pure in his genetic make-up for the factors that insure high levels of milk production. Thus, the use of such proved bulls for several generations gradually builds up milk production in the herd.

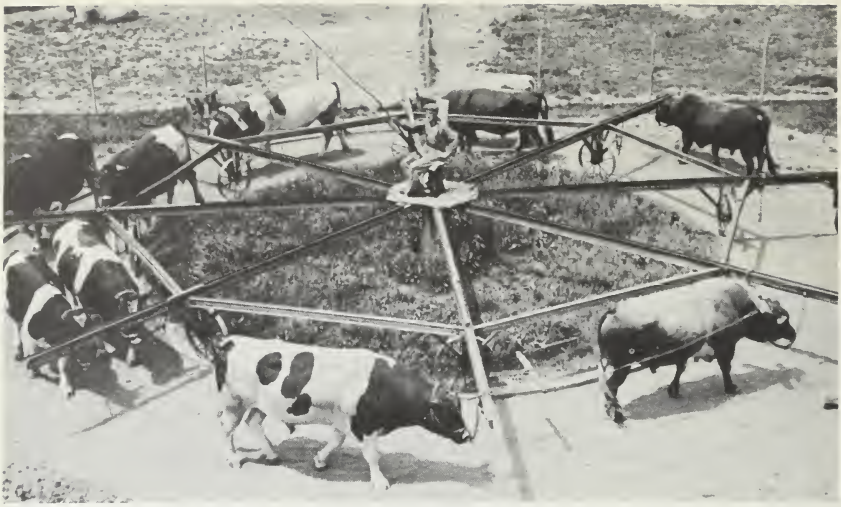
On the dairy farm the cows that do not pay for their keep are usually culled, but at Beltsville the object is to get information on breeding. Therefore no females are culled from the herd. All are raised and tested for production. Every effort is made to avoid practices that might interfere with or bias the interpretation of results in terms of inheritance.

A herd of registered Holsteins was established at Beltsville in 1918, and a herd of Jerseys in 1919, for experimental purposes, particularly to determine the value of using proved sires. To date, 7 proved sires have been used in the Holstein herd, and 15 in the Jersey herd. The average butterfat production of the foundation cows in the Holstein herd was 678 pounds a year, and in the Jersey foundation herd it was 622 pounds.

In both herds the number of low-producing daughters has gradually diminished with each succeeding proved-sire cross, and butterfat production per cow now averages more than 200 pounds higher than for the highly selected foundation cows—an increase of approximately 30 percent.

Proved sires brought in for service at Beltsville are usually past 7 years of age. This is beyond the prime for the majority of dairy bulls. Daily exercise has always been highly regarded as a conditioner and as a

A high-producing Jersey cow and a Red Sindhi bull pose with their young son at Beltsville. The father is a member of the humped Braham breed of cattle, one of a group imported from India in 1946 by the Bureau of Dairy Industry. An experiment is under way to combine the heat resistance of the Red Sindhi with the milk-producing capacity of the Jersey.



The Beltsville "bull merry-go-round."

method to prolong the usefulness of bulls. However, few old bulls will voluntarily exercise themselves, so a compulsory exercise program was set up at Beltsville. An exerciser was designed and built which has forced many a herd sire to walk himself into a useful old age.

Young bulls from the Holstein and Jersey herds are loaned to cooperating dairymen, institution herds, bull associations, and artificial-breeding rings. The purpose is to determine their transmitting ability by comparing the production records of their daughters with those of the dams of the daughters. About 80 percent of these bulls in cooperating herds have sired daughters that have produced more milk and butterfat than their dams. On the average, all daughters of the Beltsville-bred bulls have exceeded their dams in production by approximately 800 pounds of milk and 38 pounds of butterfat.

In 1939, a cross-breeding experiment was started at Beltsville to develop as much useful information as possible. Proved sires of the Holstein, Jersey, and Red Dane breeds are being crossed with females of these three breeds and also with Guernsey females. To date the majority of the two-breed females have produced more milk and butterfat than their purebred dams, and the majority of the three-breed females have produced more than their two-breed dams. One of the striking characteristics shown by all the crossbred heifers is their persistency in milk production.

The Dairy-Anatomy Puzzle

How to identify high-producing cows on the basis of appearance and body characteristics has puzzled dairy-cattle breeders for 150 years. Many

have thought they have found the answer and have offered what seemed to be convincing evidence. Some still cling to theories of a century ago. From time to time new theories have been advanced. There is little if any scientific basis for most of the theories, although large sums are spent every year in conducting cattle shows and in teaching the principles of dairy-cattle type and judging to farm boys and girls, college students, and dairy farmers. A dependable knowledge of the significance of dairy form is much to be desired since at least 95 percent of dairy animals are selected without the aid of production records.

To provide a proper basis for identifying both superior and inferior producing capacity, Beltsville scientists have conducted a study that involves the measurement of body form in the heifer and in the cow and the determination, after slaughter, of size of all internal organs and body parts. Already more than 400 cows with records of production have been slaughtered and measured at Beltsville according to this procedure. In addition, more than 450 cows of known producing capacity have been slaughtered in accordance with the same plan and as a part of the same study at various State experiment stations. The work has already provided data showing how dairy animals grow and how their form changes with age, and also the average weights and measurements of the anatomical parts—all as a scientific approach to the yet unsolved puzzle of judging production from conformation.

As a prelude to this work a comparative study was made of a highly specialized dairy cow (a former world's champion butterfat producer), a highly specialized beef cow (an Aberdeen Angus show cow), and a dairy bull. The most striking revelation was that, despite extreme variations in body form, the internal anatomy and the skeletons differed surprisingly little. The complete skeletons of these three animals, mounted according to body measurements taken on the living animals, are kept at Beltsville.

Dairy Cattle Nutrition and Management

Research in nutrition and dairy-herd management has contributed to the solution of several problems connected with the rearing of calves for herd replacements and the production of milk. For instance, it is estimated that calves consume about 1,750,000,000 pounds of whole milk annually. That this quantity may be reduced is evident from research work at Beltsville, where calves have been reared without the use of any marketable whole milk and have been weaned at various ages from all milk and milk products. Other research has shown that growing calves will eat more hay when they have free access to it all day than when it is fed several times a day. Experiments also show that colostrum milk, which is essential for proper nourishment of new-born calves, can be fed to older calves safely when it is properly diluted with warm water.

Colostrum is a highly concentrated feed and provides more nutrients, pound for pound, than whole milk.

The simple, open-shed system of stabling cows has been found to be satisfactory under Beltsville conditions. Cows housed in this manner produced as much milk, stayed as healthy, and kept as clean as those stabled in the common type of closed barn. This research proved that an expensive barn is not necessary. If cows are kept dry and out of cold winds, the essential conditions of satisfactory housing, from a production standpoint, are largely met.

Another investigation was to determine the influence of frequency of milking on the quantity of milk. When cows were milked three times a day for whole lactation periods, they gave about 20 percent more milk than when milked twice a day. Farmers with sufficient help can thus increase milk production without more cows or housing facilities.

Pasturage can be the best or the poorest of feeds. Beltsville research has shown that, when the grass is young and abundant, cows will graze enough to support a production twice that of the average cow; but when the grass is dried up, short, or matured, as is often the case in midsummer, the cows may not graze enough to support the production of more than a few pounds of milk a day. Studies extending over several years are now in progress on methods of renovating and various ways of treating pastures, methods of crop rotation with pastures, and various methods of pasture management.

These cows are grazing their fill of succulent grass from an improved pasture—a pleasant sight to any dairy farmer. Pasture research at Beltsville deals with renovation, new grass and legume mixtures, rotational grazing, liming, fertilizing, and manuring, and pastures used in rotation with other farm crops.

The Bureau of Dairy Industry has been conducting research for several seasons to find the best method of saving the nutrients grown on the farm in the form of roughage. Comparing three different methods of harvesting and storing hay crops—field curing, barn finishing, and making wilted grass silage—the investigators showed that with the same crop, the losses of dry matter, protein, and carotene (vitamin A) were greatest when hay was cured in the field, next when it was dried in the barn without heat, and least when it was made into silage. Experiments have demonstrated that, through proper control of moisture, good silage can be made from any of the hay crops and it is unnecessary to add molasses, acid, or any other purchased materials. To take the place of pasturage and prevent the summer slump in milk production, no feed excels good grass silage.

A vitamin A deficiency in young dairy calves may cause the development of a cyst in the pituitary. Hormones secreted by this gland are essential for reproduction and lactation. Results at hand indicate that, at least in the male, the subsequent feeding of vitamin A does not cure these cysts, but that animals may be fertile even when large cysts are present. Further work is needed relative to the extent to which such males can be used. Work with females that have probably developed these cysts is now in progress to determine whether they will reproduce and lactate normally.

A preparation from casein and iodine called an iodized protein or iodinated protein has been shown to function like the hormone thyroxine, which is secreted by the thyroid gland, and to have a tendency to increase milk production when fed to cows in the declining phase of their lactation. This increase is temporary unless the cow is fed large amounts of feed. Experiments are under way to determine what the long-time effects of the drug will be on the productivity and health of the cows.

Investigations are being conducted on the nutritive value of milk and methods of improving it, particularly its vitamin A potency. This work long ago showed the presence of an unidentified nutrient in milk, which was called nutrient X. Recent work has identified nutrient X as vitamin B_{12}. This new vitamin has been found in the nonfat portion of milk, in cheese, commercial casein, leafy foods and feeds, and in liver extracts, but not in the cereal grains and oil meals.

Other experiments are in progress to determine the level of protein most practical to feed to cows; the minimum amount of calcium required by growing calves; the effect of feeding rations consisting of grain and corn silage; the vitamin A requirement of calves; the occurrence of nutritional anemia in young calves; and the feeding of older calves on all-roughage rations.

BUREAU OF ANIMAL INDUSTRY

Breeding and Feeding Farm Animals

Livestock breeders have not advanced as far as plant breeders in applying genetics to the solution of their problems. This is partly because farm animals are less prolific than plants and the opportunity for selection of the progeny is consequently more limited. However, small animals such as mice and guinea pigs multiply rapidly, and genetic studies conducted with them often provide the foundation for subsequent breeding experiments with larger animals. The aims of animal-genetic projects are to uncover new principles of farm-animal improvement and to test old theories.

Quite as fundamental as research on animal breeding is that which seeks to discover the principles underlying animal nutrition. The efficient use of feed supplies in producing meat, milk, eggs, wool, etc., is based largely on the results of scientific experiments. Facilities are provided at the Research Center for intensive physiological and nutritional studies on animals to answer such questions as: How do various kinds of feed affect the characteristics of fat deposited in animals? How much and how good a protein in the ration is necessary for maintenance, growth, and reproduction? How important are the mineral elements in a ration—which minerals and how much of each one are required? What are the vitamin requirements of different classes of animals? What is the relation between the composition of a ration and the quality of the meat of an animal receiving it? Various classes of animals are kept under close observation and fed specially prepared diets in studies designed to provide answers to these questions.

The research program with dual-purpose cattle is confined to problems relating to breeding for beef and milk. The dual-purpose herd at Beltsville is of the Milking Shorthorn breed. Approximately 160 head of cattle of all ages are maintained, making available about 90 females for breeding. The general plan is to develop lines of dual-purpose Shorthorns capable of producing offspring that will make rapid and efficient gains, produce high-quality products, and possess the desired type, conformation, and, in the case of breeding cattle, high fertility.

In developing this plan, a standardized procedure for testing or proving breeding cattle is followed. By subjecting the offspring to individual tests, a record of the performance of a definite number of calves by each sire is obtained. The breeding ability of a bull is measured largely by the rate and efficiency of gains of his calves, quality and type of calves, and carcass and dressing percentage in the case of slaughter steers. In proving

a sire, the first bull calves (approximately 8, unselected) are castrated at 140 days of age, weaned at a weight of 500 pounds, and then put on a fattening ration and fed individually until they reach 900 pounds weight, when they are slaughtered and the quality of the carcass and dressing percentage are determined. The rate of gain by calves from birth to weaning at 500 pounds is recorded. The records of feed consumed and of the rate of gain made by the calves in the fattening period serve as the basis for measuring the breeding ability of the bull from the beef standpoint.

In these record-of-performance studies, the greatest emphasis is placed on rate and efficiency of gain and quality of product. Efficiency in these studies is considered as the pounds of live-weight gain made from 100 pounds of digestible nutrients. Studies are made with heifers to determine their ability to use feed for a period following weaning at 500 pounds until they reach 700 pounds. Heifers are bred at 18 months of age. All heifers are milked for 305 days of their first lactation period and are rebred to calve in 13 months.

The proving of bulls, or sire testing, through record-of-performance studies with the offspring is a slow process. If bulls are tested as 2-year-olds they will be about 5 years old before much is learned about them. So far, 16 Milking Shorthorn bulls have been proved at Beltsville.

Efficient Beef and Milk Production

As an example of the progress being made in the production of beef by Milking Shorthorn steers, the first 38 steers fattened and slaughtered at the beginning of the project dressed 57.29 percent and required 489 days to attain a slaughter weight of 900 pounds, whereas the last 43 steers dressed 60.37 percent and weighed 900 pounds at 441 days of age. Although this is only a slight increase in dressing percentage, the last group was finished in an average of 48 days less time. The average production of 127 head of Milking Shorthorn cows has been 5,823 pounds of milk and 225 pounds of butterfat for 305 days of their first lactation. The trend has been for the cows with the highest milk yield to produce steers with the lowest carcass grade.

In addition to the foregoing results, there has been a tendency for calves heavier at birth to reach a slaughter weight of 900 pounds in a shorter time and to be somewhat more efficient than the lighter calves. There has been a close relationship between rate of gain and efficiency of gain during the fattening period (500 to 900 pounds).

Progress in Hog Improvement

Research on hogs at Beltsville is conducted on an area about 2½ miles southeast of the Nutrition Laboratory (2.1). The plant includes a farrowing house (5.1), record-of-performance house, feed barn, and 35 colony houses on individual pastures. A breeding herd of about 200 hogs is maintained, and approximately 250 litters of pigs are farrowed annually.

Styles in hogs have varied widely through the years—from small, short, plump types to larger, longer, narrower hogs. In recent years the trend has been toward a medium type that gains as economically as the larger type hog but produces the medium-sized cuts of meat favored in today's market. Buyers like hams of 10 to 14 pounds and bacon with plenty of lean. Swine breeders try to develop hogs that will butcher well both for lean hams and loins and for a good proportion of bacon.

The Department's hog-breeding program at Beltsville is concerned primarily with the development of superior strains of hogs from crosses of the Danish Landrace (a long, smooth, bacon-type hog) with American breeds. Special attention is given to the effects of different systems of breeding on such characters as prolificacy, mothering ability, vigor, growth rate, and efficiency of feed utilization.

In experimental work to determine the vitamin requirements of swine, the B vitamins have been the chief subject of study. Results have shown

It's easy to see that the pig in the middle "takes after" both his Poland China mother (left) and his Danish Landrace father (right).

that the thiamine requirements of young pigs vary with the fat content of the diet and are directly dependent on the carbohydrate and protein intake. The thiamine content of pork has been found to vary with the thiamine intake of the pigs. Study of the peculiar type of lameness in pigs known as locomotor incoordination has shown that this disease is primarily the result of pantothenic acid deficiency. Numerous other vitamin factors are being studied also.

Experimental work has shown that feeding additional protein to suckling pigs is a means of stepping up pork production. When pigs 3 weeks old were given free access to protein feeds—for example, skim milk, tankage, soybean meal, or peanut meal—for 11 weeks, the added protein gave greater gains and the pigs reached market weights about 2 weeks earlier than those raised in the usual way.

Tests have been conducted on the use of a greater proportion of protein feeds of plant origin, such as soybean, peanut, and cottonseed products, in the fattening ration of swine. Other studies are in progress on new feeds and on improvements in value of byproduct feeds through better processing.

Experiments have shown that home-grown legume hays, such as alfalfa, lespedeza, and soybean—feeds formerly considered too bulky for hogs—can be used to advantage to help balance the ration and lessen the amounts of other feeds needed. The hays are fed in the form of a ground meal and constitute not more than 10 percent of the ration. Other studies now in progress deal with the part that vitamins play in the health and growth of hogs.

More Productive Sheep and Goats

The experimental flocks at Beltsville contain about 540 sheep and 100 goats. Breeding investigations are centered largely on selective mating and line breeding of Hampshire, Shropshire, and Southdown sheep for the development of improved strains adapted to eastern farming regions. Results have shown that, through careful culling of rams and ewes and the progeny testing of rams, production can be increased materially over that accomplished with usual selection practices.

In fur-sheep studies, experiments are under way with Karakul sheep, which are no longer being imported. The purpose is to explore the possibilities of producing high-quality lambskins for the fur trade by selective breeding of the relatively few Karakul sheep in the country. Methods of skinning pelts from Karakul lambs and of preserving the pelts for fur are also studied. The work has demonstrated that cross-bred sheep, produced by breeding ewes of the usual breeds raised in the United States to purebred Karakul rams, can be graded up to approach closely the quality of purebred Karakuls for fur production. Satisfactory results are obtained in the fourth to sixth top cross with good purebred Karakul rams.

These quadruplet kids were born to their Saanen mother at Beltsville. Such multiple births are rare among goats.

In milk-goat investigations, animals of the Toggenburg and Saanen breeds are used. Studies are made to determine the inherent capacity of goats for efficient production of high-quality milk. The use of bucks from high-producing lines of breeding has contributed greatly to herd improvement.

Better Poultry and Eggs

The experimental poultry plant at the Research Center includes 177 acres on which are 4 well-equipped laboratory buildings (2.6), 10 large laying houses, 3 long brooder houses, 4 large turkey houses, a shop, and nearly 200 colony houses of various sizes for the experimental flocks and equipment. The poultry buildings have a capacity of approximately 8,000 adult chickens and 1,500 turkeys. Facilities are available for brooding about 13,000 chicks and 2,500 poults. About 150,000 eggs are incubated each year. The experimental flocks are made up principally of Rhode Island Reds and White Leghorns.

The most successful way to select good poultry stock for breeding is to follow the "three P" program—production records, pedigrees, and progeny testing. The principle of mating only the best available individuals from the best families has led to the establishment of lines which

produce eggs of larger size with stronger shells, few blood spots, and a high percentage of thick white. Consumers like eggs with thick white that covers the yolk uniformly when the egg is poached or boiled. Selective breeding has developed another line of chickens whose eggs withstand heat deterioration unusually well.

Selective mating of standard-bred chickens has produced and maintained lines of Single Comb White Leghorns and Single Comb Rhode Island Reds from which the average pullet lays about 200 eggs during her first laying year. Breeding research with crosses between selected Reds and Leghorns, with and without previous inbreeding, indicates that these mating methods may be useful in improving viability and average egg production under less favorable conditions.

Research on hatchability in chickens and turkeys has disclosed several harmful genetic factors, some affecting the egg, which may be eliminated by selective breeding. Poor hatchability also results from several vitamin deficiencies in the diet of the breeding flock. These dietary deficiencies can usually be remedied by feeding a good breeder mash. Chicks that do hatch from deficient eggs are sometimes handicapped so that they grow slowly or die during the first few days of brooding.

An important poultry activity at Beltsville is the administration of the National Poultry Improvement Plan. More than 60 percent of the billion and a quarter chicks and poults hatched in the United States are produced at hatcheries cooperating in the breeding improvement and pullorum disease eradication programs of the Poultry Improvement and Turkey Improvement Plans. Breeding improvement and pullorum eradication work done by cooperating breeders and flock owners is an important factor in the sharply increased egg production and decreased brooding mortality of farm flocks now as compared with those of a few years ago.

The Beltsville Small White Turkey

In recent years a demand has developed for smaller turkeys to meet the needs of small families and to fit kitchenette ovens. Poultry breeders at Beltsville have succeeded in producing a small-type turkey, white in color, with a compact body, short legs, a long keel bone, and plenty of breast meat. This Beltsville Small White Turkey is the result of a combination of several varieties, each contributing one or more of the characteristics desired. White Austrian turkeys from Scotland were the principal reliance for small size and whiteness. Native wild turkeys exerted an influence for smallness and contributed the meaty breast. White Holland, Bronze, and Black turkey varieties helped impart the tendency toward early maturity. The best individuals in the Research Center's flock now approach the ideal for the new turkey.

A tom turkey of the Beltsville Small White breed.

The average live weight of market turkeys produced in the Small White flock ranges from 13 to 16 pounds for the males and 8 to 10 pounds for the females, as compared with average weights for most market turkeys of 20 pounds for males and 12 pounds for females. The weights of the Beltsville type are within the weight limits desired by fully 75 percent of the retail purchasers. The birds are in finished market condition at the age of 24 to 26 weeks.

Poultry Diets

Specialists in poultry nutrition at Beltsville have developed more efficient and more economical diets in which soybean meal is the major source of protein. They demonstrated the existence of a previously unknown dietary essential, the requirement for which is increased when soybean meal is fed. This factor is supplied by fishmeal (as 4 percent of the diet), by dried skim milk, and to a lesser extent by meat meal. Experiments conducted during 1948 showed that this factor is vitamin B_{12}, which was isolated in other laboratories from liver as a growth factor required by certain bacteria. Crystalline vitamin B_{12} has been

demonstrated to be essential in the diet of growing chicks to support satisfactory growth. It has also been shown to be essential in the hen's diet to permit normal viability and feathering of chicks. Vitamin B_{12} is known to be present in dried cow manure.

The standard recommendation of 21 percent of protein in the diet of growing chickens is based on work done at Beltsville in 1938.

Extensive studies have been made of the effect of temperature on efficiency of feed utilization. During the first 9 days after hatching, it was found that the customary practice of starting chicks at 95° F. and reducing the temperature at the rate of 5° each week gave a maximum efficiency of 0.38 gram of gain per gram of feed. Efficiency was reduced at either higher or lower temperatures.

Improving Meat Quality

The ultimate measure of the success of various systems of livestock production is the quantity and quality of meat produced. Detailed laboratory, cooking, and palatability studies are made on the meat from animals slaughtered in the experimental abattoir. These observations include physical and chemical analyses, color reading, histological (tissue structure) examinations, and mechanical tests for tenderness, as well as cooking tests and palatability judging and grading by experts. Experiments with different methods of processing and storing meats are conducted also.

Other problems under consideration by meat investigators at Beltsville are the causes of dark-cutting beef, the relative palatability of grass-fattened and grain-fattened beef, and the relation of age, sex, breeding, and feed to meat quality. The studies include animals produced both at Beltsville and at cooperating Federal and State stations.

A wealth of information has been collected on the effect of freezing and of storage at various temperatures and for varying periods on tenderness and other qualities of beef, pork, and lamb. The information is being put to good use by the meat industry and freezer-storage establishments. Freezing beef, for example, has been found to increase its tenderness. Beef was more tender when it was frozen at $-10°$ or $-40°$ F. than at $+20°$. Lamb rib cuts frozen and stored in air-tight containers at 0° were of satisfactory quality after 168 days in storage. There was a definite decrease in desirability, however, when the cuts were held in storage for 280 days, indicating that 6 months is as long as meat should be stored even at that temperature.

In a study to find substitutes for paper and other wrapping materials used in protecting meat from shrinkage or "freezer burn" in storage, dipping the frozen meat in melted lard proved to be satisfactory. The lard coating is easily removed by hot water or by placing the meat in a warm oven.

Animal Fiber Work

At the Animal Fiber Laboratory, in building 2.1 on the map, fleeces are analyzed to determine the influence of breed, feed, and management factors on the quantity and quality of wool. Wool, mohair, and other animal fibers are analyzed for structure and properties affecting their value in manufacture. Two rapid tests of fineness and variability in wool, developed at Beltsville, expedite the determination of these characters in sheep to be selected for breeding stock.

The relative merits of yearling lambskins for mouton fur production are now being investigated. Recently, lambskins of the merino type, varying considerably in fineness and density, have been processed into mouton fur. The wool on each of these skins has been measured for fineness of fiber, density of wool growth, and size and thickness of skin. Thick leather and rib marks on the fur caused by too many wrinkles on the lamb before slaughter are characteristics of inferior skins.

Feathers are used as filling material for pillows and upholstery and may also be converted into feather fiber and manufactured into fabric. There is a wide range in the filling quality of feathers and the spinning quality of feather fiber. Feathers vary according to breed and age of fowl, and climate also affects them. Feathers are graded by airflotation. Their air buoyancy or degree of fluff is determined by blowing them up in a vertical tower with openings at different levels. Separated in this manner, they may be accurately classified and blended.

Livestock Diseases Attacked by Science

Research projects in animal diseases usually extend over a period of years, and the importance and practical application of the results may not become apparent for a number of years more. Most of the livestock-disease work at the Agricultural Research Center is conducted at the Animal Disease Station, which is a unit of the Pathological Division, Bureau of Animal Industry. The station covers an area of approximately 350 acres, about 100 of which are used for growing feed crops for the experimental animals.

The 200 structures on the station grounds include laboratories, hospital houses, small-animal breeding houses, an incinerator, and various barns and pens. About 800 large experimental animals, comprising horses, cattle, sheep, goats, and swine, and in addition about 1,000 head of poultry, are maintained. Numbers of small animals, such as guinea pigs and mice, are raised to supply the needs of the Animal Disease Station and other laboratories of the Bureau.

Brucellosis of cattle (Bang's disease) has received major attention. It was at this station that the antibrucellosis vaccine (strain 19, *Brucella abortus*), now widely known throughout the world, was first made. The

studies have shown that no medicine now known can cure the disease but that vaccination of calves is a preventive.

Brucellosis in swine, anaplasmosis and mastitis of cattle, and sterility in cattle resulting from hormonal imbalance also receive major attention.

Other diseases under study are infectious anemia and sleeping sickness of horses; tuberculosis of cattle, swine, and poultry; paratyphoid and erysipelas infections of swine; vesicular stomatitis of cattle, hogs, and horses; and fowl typhoid and Newcastle disease of poultry.

All diagnostic antigen used in the Federal-State program for the control of Bang's disease, and strain 19 vaccine are prepared at the Animal Disease Station. All similar commercial products are tested here for purity and potency.

Research on diseases that resemble foot-and-mouth disease and thus may be confused with this foreign malady has provided information that aids in a prompt and correct diagnosis when foot-and-mouth disease is suspected. A school of training for Bureau veterinarians in the field has been initiated at the station.

Strategy Against Livestock Parasites

Another section of the Research Center, comprising approximately 110 acres, is devoted to animal-parasite investigations. A part of this area is divided into 54 plots, varying in size from ¼ acre or smaller to 5 acres, which are used as pastures or for small-scale field experiments. About 500 large animals, including horses, cattle, sheep, goats, and swine, and about 1,200 chickens and turkeys are maintained for experimental purposes. The improvements consist of an administration building, 3 laboratories, and 4 other buildings used for research studies. In addition, there are 75 miscellaneous buildings, barns, and shelters for the animals, an incinerator, and other miscellaneous structures.

Here zoologists and parasitologists of the Bureau of Animal Industry study the vast number of parasites that attack livestock and develop treatments and control measures to protect domestic animals and poultry from them. Part of the strategy in waging war on these pests is to determine the most vulnerable points in their life cycles and then find a drug or husbandry practice that will break the cycle. Such research has developed treatments with phenothiazine for removing injurious worms that infest horses, cattle, sheep, swine, and poultry; sodium fluoride for removing roundworms from swine; and with lead arsenate for removing tapeworms from sheep.

These and many other discoveries have helped to make livestock and poultry raising safer and more profitable. Sometimes the results of research show how a combination of methods can best be used. For instance, the experimenters found that larvae of the stomach worm, nodular worm, and other injurious internal parasites of sheep did not

survive under pasture conditions for more than 4 months. This fact formed the basis of a control program that involves treatment of the breeding flock with phenothiazine late in the fall and early in the spring and then placing the sheep on pasture that has been allowed to lie idle over winter. These facts are useful in formulating control measures for the parasites.

Vaccinating a 7-month-old calf at the Animal Disease Station for protection against brucellosis.

BUREAU OF HUMAN NUTRITION AND HOME ECONOMICS

The Consumer's Angle

The chief governmental agency designated by Congress to study the use of food, fabric, and other goods and services from the standpoint of the ultimate consumer is the Bureau of Human Nutrition and Home Economics. The laboratories and offices of the Divisions of Food and Nutrition, Housing and Household Equipment, and Textiles and Clothing of this bureau are in buildings 3.1 and 3.3 at the Research Center.

The following examples of recent or current research will give a panoramic idea of the bureau's work at Beltsville.

Better Home Freezing and Canning

Twenty million or more families in this country annually preserve some of their own food. To help the American people do this work in practical ways, with methods that will prevent spoilage and retain the most food value and flavor, is the aim of food specialists, bacteriologists, chemists, and physicists in the food, nutrition, and equipment laboratories.

The increasing number of home freezers in the Nation and the relative newness of this field of home food preparation puts new emphasis on food-freezing research. Testing various foods in the food-freezing laboratories, scientists experimentally prepare, package, freeze, and hold in frozen storage each of the foods to develop better freezing methods. Scalding vegetables to destroy enzymes has been found necessary to retain their nutritive value, color, and flavor. The amount of scalding necessary has been determined by recording temperature changes in the food and testing for enzyme activity for different scald times.

The color and flavor of fruits that darken readily, such as peaches and nectarines, have been successfully retained through frozen storage and thawing by the use of ascorbic acid and by providing sufficient sirup to cover the fruit. Studies with York Imperial apples show the effects of various chemical and heat treatments on the quality of apple slices in freezing. Steam blanching, for instance, gives the apple slices better color, but those frozen without blanching have better flavor and texture. Techniques for preparing and packing fruits such as blueberries, straw-

berries, and rhubarb for freezing in sugar sirup and in dry sugar have been developed.

Studies comparing home-canned and home-frozen snap beans showed the freshly frozen beans considerably better in eating quality than the canned. Frozen beans were superior to the canned in both flavor and color.

Home economists use assembly-line techniques for packing jars of food while doing research on home canning.

From its freezing experiments, the bureau has built up and put into an illustrated, how-to-do-it booklet directions for home freezing of fruits and vegetables. An educational motion picture in natural color has also been made on the subject.

When food is well prepared and packaged for freezing, the freezer and storage cabinet take over responsibility for a good product. Hence, one research group has investigated home freezers themselves—their ability to freeze food quickly and hold it at temperatures best for retaining quality. A freezer should be capable of continuing this service year after year at economical operating cost. A method of testing the performance of home freezers has accordingly been worked out.

Improved processing methods for home canning are the aim of the bureau's home canning research. This work includes studies to learn the effect of preparation and packing on the eating quality and retention of essential nutrients in home-canned foods. Three years of intensive research have yielded new and improved processes for the home canning of meats and the 12 most commonly canned low-acid vegetables. The new methods replaced many older processes which were not only time consuming but resulted in home-canned meats and vegetables often inferior in appearance, taste, and nutritive value.

Based on this work, the Department's how-to-do-it home-canning bulletins now give processing times 25 to 50 percent shorter than previ-

ously for vegetables canned in pint-size jars, and for some in quart jars. For foods home-canned in tin, the recommended processing times are now similar to those in commercial use. For home-canned meats, recommendations for processing temperature and amount of pressure to use have been lowered. Using a steam-pressure canner—the only safe method for processing low-acid foods—and following the new schedules, homemakers may now turn out products combining safety with better flavor and food value than before. In addition, the new methods save both time and fuel.

Cookery—Small and Large Scale

In the laboratory kitchens at Beltsville, cooking methods and recipes are developed for home use and for school lunchrooms. At times, the staff has experimented with cookery of new foods, such as soy flour and grits and turkey cut-ups—one of the newer forms in which big birds come to market. Research is also done to find new ways and more ways of preparing familiar foods. For example, short cuts for the homemaker in cooking dried beans and peas are now sought; also ways for the family to use the cheaper kinds of chicken, such as small, mature hens. Potato varieties grown in different localities and stored in different ways are being compared to learn which potatoes are best for boiling, baking, and French frying.

Under uniform lighting, trained judges from the Bureau of Human Nutrition and Home Economics staff score foods prepared in the experimental kitchens, rating flavor, appearance, texture, and other fine points.

The school-lunch research of the Bureau of Human Nutrition and Home Economics is supported in part by the Production and Marketing Administration—the Department's branch in charge of the national school-lunch program. One of the experimental kitchens is equipped for large-scale cookery, and here recipes utilizing abundant foods are developed for use in school-lunch programs. Adapted to family size, many of these recipes become useful also to homemakers.

In the bureau's food laboratories all recipes are judged for palatability, and school-lunch recipes get an added test in cooperating schools, where they are prepared by the school-lunch cook and served to the pupils. A bureau representative is present to watch the children's choices, hear their comments, and note whether any of the food is left on the plates. Recipes which the children like are published from time to time. Besides experimenting with cookery, the bureau is seeking to learn how well school lunches actually served are meeting children's nutritional needs. Sample lunches from cooperating schools are analyzed in the laboratory to determine the content of important nutrients.

Proteins and Plants

Protein—required by the body for tissue building and repair—is one of the substances in which world food supplies are short. Best known sources are animal foods, such as meat, milk, eggs, and cheese, which contain high-quality protein. Most plant foods also provide some protein. So the faster scientists can learn about the nature of proteins in all kinds of foods and how to combine them to advantage, the nearer they will be to solving a big problem for a hungry world.

Plant proteins vary widely in value, depending on how many of the nine essential amino acids, and how much of each one, they contain; and a slow, basic task of protein chemistry is analyzing these foods for amino acids, one by one. In the bureau's protein research laboratories a number of short-cut methods have been developed which are speeding this work there and elsewhere. One method reduces from weeks to days the time it takes to determine several amino acids in a food. That the short cuts meet a need is shown by the many requests for the published results coming from hospitals, colleges, and other research and teaching institutions in all parts of the world.

The plant-protein studies have shown that the following come closest to animal proteins in nutritive value: Soybeans, peanuts, cottonseed, wheat germ, and corn germ. These have proved efficient enough in tests on animals to demonstrate that they might be counted on to stretch or spare the proteins of meat and other animal foods when these proteins are scarce, or might be an inexpensive source of protein in the diet of low-income families at any time.

What one protein lacks, another may supply. The bureau's research shows that plant foods may be used to make highly nourishing combinations to meet the body's protein needs. Strangely, such combinations sometimes prove more nourishing than the components would suggest. In feeding experiments with young rats, for example, the protein research specialists found that adding 15 parts of soybean flour to 85 parts of wheat flour in bread increased the growth-promoting value of wheat flour fivefold.

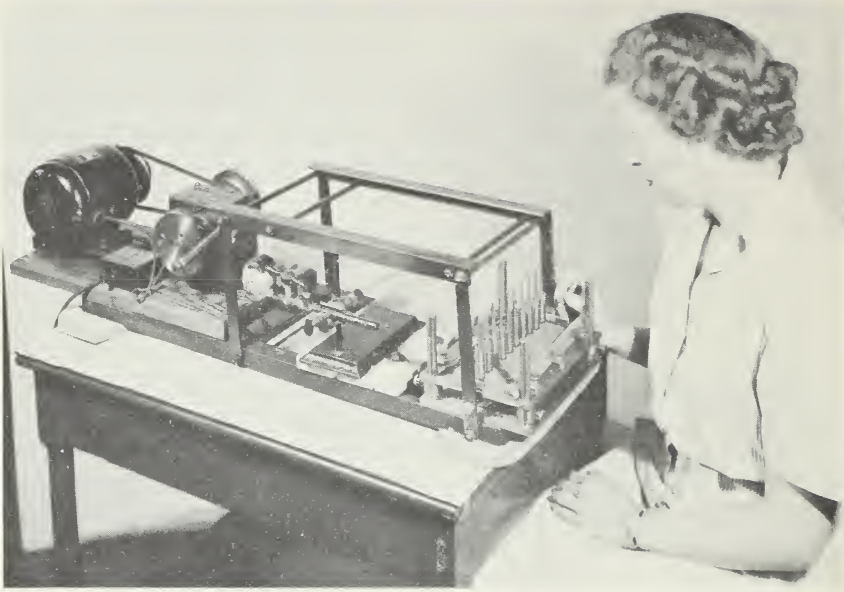
Vitamin A and Carotene

Throughout the world a large proportion of the needed vitamin A is furnished by plant foods in the form of carotenes, which the body can transform into vitamin A. Many of the factors affecting the utilization of carotene are not well understood. For example, work in the bureau's laboratories showed that the carotene in cooked kale is utilized better by the body than the carotene in cooked carrots. Even so, the vitamin A value of cooked kale, as determined by feeding experiments with the vegetable, appeared to be only about two-thirds as great as would be expected from a chemical determination of its carotene content. However, when an extract of the carotinoid pigments from kale rather than the kale itself was fed as the source of carotene, the feeding value agreed with the chemical value. This indicates that in kale, at least, the difference between the chemical and biological values may be due to incomplete digestion of the vegetable and consequent incomplete absorption of carotene from the intestinal tract. Further experiments with other carotene-rich cooked fruits and vegetables and their extracts are in progress.

Plain Facts About Fabrics

The research on clothing and fabrics from the consumer standpoint aims to show producers what people need and want in staple garments and fabrics and ways in which materials on the market can be improved to meet needs. The bureau also seeks to provide facts which will help homemakers choose, use, and care for the clothing and textile products they buy.

Some kinds of scientific textile testing have to be done where the weather never changes. For these, an air-conditioned laboratory at Beltsville is equipped with machines to measure fabrics for strength, stretch, and resistance to abrasion. Other laboratories nearby have equipment to do a scientific laundering job and to measure how much fabrics shrink on washing. An artificial sun can be turned on fabrics to show how fast or fugitive the colors are.



Wear and tear on buttonholes are simulated by an abrasion machine in research on how to construct clothing for durability.

Better care of textiles in the home calls for more knowledge about what makes fabrics deteriorate. Accordingly, other fabric studies are concerned with deterioration in cotton and—more recently—in wool and other fibrous protein materials, including casein bristles, and fibers made from peanuts, soybeans, corn, and milk. In studying the effect of certain enzymes on wool and the other protein fibers, the textile scientists found that the enzymes digested all of the manufactured protein fibers more readily than wool.

In another study, nearly 1,100 samples of staple clothing fabrics from 15 cities in 5 sections of the country were examined. Experiment stations and schools of home economics in those areas cooperated in providing and analyzing representative samples. This is the first time such a round-up of what is on the market has been undertaken. The tests of shrinkage, breaking strength, colorfastness, and other properties that relate to service and satisfaction show what can be expected of staple fabrics of different qualities. Repeated over a period of years, they would show the trends in fabric quality under changing supply and demand situations.

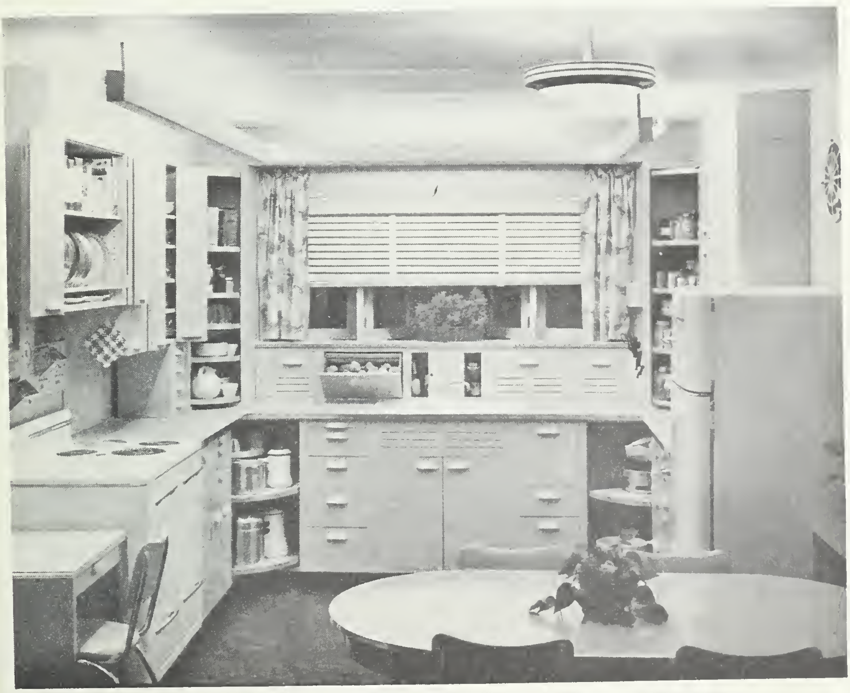
In addition to studying the textiles or the fabrics that go into staple articles of clothing, the scientists test the various construction features of garments in the laboratory. These are studied to learn what builds durability into a finished garment.

One way in which these lines of research reach the public is in buying-guide publications, designed to help the homemaker shop for household fabrics and clothing.

Designing Clothes for Women at Work

The bureau has pioneered in designing work clothes for women. The clothing specialists recognized that garments worn by women for housework, farm chores, and other jobs were likely to be unsuitable on many counts—comfort, protection, efficiency, durability, and, in some cases, safety. When the first designs for a mechanic's suit, field suit, and other functional work clothes were launched in 1941, the models from Beltsville set a standard for a new, large branch of the work-clothes industry. The garments for farm work, indoors and out, were the first ever specifically planned to meet the needs of women and girls on farms. Within a few months, about 100 companies were putting on the market garments following or adapted from the Federal designs. In addition, through cooperation of pattern manufacturers, the first 17 of the bureau's designs promptly became available in commercial patterns.

The bureau has continued to introduce improvements and add new designs to meet recognized needs for this type of women's wear. A group of summer housedresses and aprons recently brought to 43 the number of functional work-clothes designs that have been released for public use.



A step-saving kitchen, in which storage spaces, lighting, and work centers were designed on the basis of research findings, is on view at Beltsville.

Farm Housing and Equipment

In the housing and equipment laboratories, research moves forward on some of the points important to a good farmhouse. For example: How much space is needed in the farm kitchen to store food and utensils properly and to allow room to do jobs comfortably and well? A step-saving **U** kitchen designed in the laboratories puts some of these findings on space needs to use. This new-style farm kitchen is being followed by other designs.

In addition, the bureau's specialists are joining forces with architects of the Bureau of Plant Industry, Soils, and Agricultural Engineering in developing new farmhouse plans for distribution through the Plan Exchange Service, which the Department of Agriculture conducts co-operatively with the State agricultural colleges. From farmhouse plans prepared at Beltsville and at the colleges, regional committees select those which most nearly meet regional needs. State colleges then make the working drawings and plans available to farmers. Twelve plans for use in the northeastern region have recently been developed and approved in this way. Before the working drawings of half of these were ready, 25 States had requested negatives from which to make blueprints to meet farmers' requests.

The two bureaus are also preparing a series of bulletins on "Your Farmhouse," providing practical guidance for families that plan to build a new house or remodel an old one. Completed publications in the series include: How to plan remodeling; cut-outs to aid in planning; planning the bathroom. Intended for families that must do much of their own planning and construction, these publications contain few technical terms, many illustrations.

From Beltsville to You

Since so much of the bureau's work is for the ultimate consumer's benefit, results from the laboratory are channeled to the public through how-to-do-it publications, press releases, radio talks, and exhibits. Many of the publications are known as "best sellers" on the Government's lists because of the large demand for copies. For example, directions for home canning of fruits and vegetables have gone through many editions, totaling more than 10 million copies. A bulletin on stain removal has totaled nearly 3 million, and "Money-Saving Main Dishes," for which the bureau prepared and tested the recipes, more than 5 million.

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